HoNESt History of Nuclear Energy and Society

D5.3: Backcasting futures for nuclear energy and society: a qualitative analysis of European stakeholder perspectives

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Introduction to the deliverable

For deliverable D5.3, the social scientists within the HoNESt project have engaged in empirical data collection on the issue of nuclear engagement futures. This research is situated within the context of the historical analysis of work package 2, which has examined the relationship between civil society and the development of the nuclear energy sector across Europe, and work package 4, which has identified the social characteristics of risk perception, social movements of opposition, policy, civil society and regulatory actors, and processes within a range of historical case studies. Within work package 5, the social scientists have identified specific principles of engagement and are working to develop a Theory of Change both within the broader HoNESt project, and for the practices of engagement and decision-making within the nuclear energy sector (Whitton, Charnley-Parry, and al. In preparation, Charnley-Parry et al. 2017). D5.3 specifically develops a practical methodology to facilitate the process of understanding and anticipating change in engagement practices over time.

Work packages 2 and 4 have undergone stringent historical and social scientific analysis of nuclear energy in society, concerning perceptual and engagement issues from the inception of the nuclear industry up to the present day. In work package 5 one of the tasks is to qualitatively assess stakeholder representatives' perceptions of nuclear energy and society over time – from past to present, and then into the future. We organised a series of three workshops to, firstly, communicate the findings of previous work packages and stimulate dialogue around the findings of the HoNESt project (work package 6), and, secondly, to utilise expertise from a variety of industry, government, non-governmental organisation, third sector, and citizen-stakeholder groups, to assess the heterogeneous perspectives on societal and political dimensions of nuclear history, to think through contemporary debates around engagement practices in the industry and to think forward to how engagement practices and policies should (and could) be changed in the future.

Futures studies

Projecting the analysis of nuclear engagement with society into the future is a highly complex problem area, involving multiple competing interests, problems of imagination, and limits to rational deliberation. Nuclear energy and its relationship to societal engagement is, as previous deliverables have noted (Charnley-Parry et al. 2017), a "wicked" problem (Buchanan 1992). It is wicked in the sense that the fundamental research questions are difficult to define, competing interests are difficult to resolve, and the problem remains perpetually resistant to simple policy solutions or interventions (Di Nucci and

Brunnengräber 2017, King 1993). The resolution of such wicked problems is fundamental goal of the so-called "futures studies" literatures, and work package 5.3 of the HoNESt project is situated within this literature.

The social scientific discipline of futures studies is concerned with developing an understanding of what is likely to continue, and what could plausibly change within a given time frame (Boyer 1975). This involves postulating *possible*, *probable*, and *preferable* futures, and in some cases, so called *wildcard* futures (Hiltunen 2006, Steinmüller 2003). The latter are defined sometimes as *black swan* events (Taleb 2007) – low probability, high impact events that are difficult to predict because they go beyond common norms of risk management and prediction. These are futures created by so-called "unknown unknowns" (to borrow Donald Rumsfeld's expression) – they appear unexpectedly and policy authorities commonly claim that they could never have been predicted (Shrader-Frechette 2011, Hoffman-Riem and Wynne 2002).

Futures studies, though a relatively modern social scientific discipline, has its antecedents in a long history of human thought. Ancient Greek philosophers (with Plato's Republic being the outstanding example: e.g. Ross 2001) encouraged individuals to project their thinking and utilise basic methods of planning and foresight. Thomas More, building on the groundwork of *The Republic* published *Utopia* in 1516 (More and Turner 1965). Though later interpreted as political satire, the concept of *utopia* combines "eu," meaning good, and "topos," meaning place (Goodey 1970). More developed an imaginary society that some interpreted as a blueprint for the future – an ideal model of living in which all people's needs are met, poverty is eradicated, and individuals experience happiness and fulfilment (Mannheim 2013, Jameson 2005). Though illusive, the concept of utopia as an *ideal*, one in which a better society can first be imagined, planned and created, has had a powerful effect upon the political imagination. And though commonly recognized as unachievable, utopian thinking about perfecting society of the future through planning in the present, remains an important phenomenon for social scientific research.

When it comes to technological development over time, utopia is a vitally important concept for examining how imagined technological futures shape political action to achieve desirable social objectives. Of note in this regard is the work of Buckminster Fuller (1969) who proposed a *technological utopianism* and set out to create designs for cars and houses that might help lead to such a utopia. As discussed across the short country reports (SCRs) and the secondary analysis across different countries (Konrad et al. 2018), from the Atoms for Peace rhetoric in the 1950s onwards, nuclear power was socially constructed in technological utopianist terms - the technology was promoted as a means to alleviate energy poverty, facilitate rural electrification, and ensure energy security, as well as (in some cases) to produce plutonium to defend

national interests (see in particular Freeman 2010, Weart 1988, Duffy 1997). However, also of concern is its counterpoint – *technological dystopia* which concerns itself with and focuses commonly on the negative effects caused by new technology (Rushkoff 2002). With global crises ranging from catastrophic climate change, ocean acidification, biodiversity loss, ocean plastic waste, biological, cyber-war or nuclear armed conflict, media reporting and civil society dialogue around such catastrophic existential risks, suggests that humanity is entering a period of long-term socio-technological decline into unsustainable and un-liveable dystopian futures. In relation to nuclear energy, this discourse is found in newspaper representations, whereby the technology is described using negative language drawn from a source domain of apocalypse, devastation and sickness (Renzi et al. 2017). The perception of dangers and dysfunctions inherent to technological progress are therefore equally (if not even more) motivating as those of technological utopianism. This is because the motivation to avoid future dangers is matched by the human need to create plans and move forward (Slaughter 2003). Thus, we find that when decision-makers imagine the future of a technology they will often to present futures in binary utopian/dystopian terms, and then tend to gravitate towards one these polar extremes (Keulartz et al. 2004, Rodríguez. 2014, Maroto-Valer 2017). How to learn from and balance between the idealised extremes of utopian and dystopian thinking to develop a more pragmatic "middle ground" for effective civic engagement with risk bearing technologies such as those involved in nuclear energy production is therefore worthy of empirical research (see for example Sjöberg 2006). At the point of a *nuclear renaissance* (Nuttall 2004, Darst and Dawson 2010), whereby there is interest across Europe in renewing nuclear energy through 3rd and 4th generation reactor designs under conditions of climate change mitigation, global competitiveness and security of energy supply concerns in an increasingly electrified society, understanding how such positive and negative imaginings of technological futures is an important research task. D5.3 aims to address how such futures can be imagined and evaluated, by drawing upon the expertise of nuclear industry, academic and citizen-stakeholders.

Concepts in future studies

It is important to note that futures studies as a social scientific discipline tends to differ in its approach to modelling future systems from those found in the mathematical, physical and natural sciences. In the latter disciplines, relatively narrowly specified systems are often studied (e.g. through predictive, logistic regression or Bayesian models). *Modelling* is commonly applied to predict how nuclear energy systems/infrastructures will adapt under differently defined socio-economic, technological and environmental conditions (for example:

Vaillancourt et al. 2008, Omri and Chaibi 2014, Samaras and Victoria 2008, Ashley et al. 2014). The discipline of futures studies, however, often concerns larger, more abstract, inter-dependent and 'fuzzier' systems - the aim is to understand the interrelated complexities between technological design, policy, and civic engagement, as is the case here.

With regards to nuclear energy, we posit that such systems are fundamentally *sociotechnical* - in the sense that they are composed of both technical and human elements which operate in concert with one another to create an emergent system (one that is 'greater than the sum of its parts'). In the social scientific discipline of Science and Technology Studies (STS), sociotechnical systems such as nuclear energy facilities can be variously understood as *imaginaries* (Jasanoff and Kim 2009, Molyneux-Hodgson and Hietala 2015), *actor-networks* (Cotton 2015, Ruuska et al. 2009), *assemblages* (Müller 2015), or *entanglements* (Shackley and Green 2007). Though these concepts are to some extent epistemologically distinct, they are very similar ways to understand such systems. First, each concept seeks to understand how a system such as a nuclear power station has been socially constructed - in the sense that it is not solely a technical system composed of material elements, but rather is shaped by human action and thought. Sociotechnical systems are understood to be interpreted through histories, social biases and heuristics. There is no isolated technical system that exists independently of these psycho-social dimensions. Second, the future development of nuclear energy is dependent not only upon design efficiency, resource availability and technical expertise; but also upon broader forces that influence the technology and its use. These are socio-cultural, economic and political and include (but are not limited to) social movements of opposition, media bodies that communicate economic and risk information, fossil fuel prices, public perceptions of the environmental impacts, health and socio-economic consequences, and the preferences of policymakers that are (in the context of democratic systems) heavily influenced by constituents' interests and geopolitical concerns (Brexit being a notable contemporary example).

The social science of nuclear energy has illustrated the various interrelated sociotechnical dimensions. Firstly, this includes issues of how nuclear power is perceived in relation to radiological risk perception across the nuclear fuel cycle (Jenkins-Smith and Silva 1991, Wynne 1993, Parkhill et al. 2010, Sjöberg 2003, Espluga Trenc et al. 2017), how issues of catastrophic risks are interpreted and negotiated (Shrader-Frechette 2011, Perrow 1999, Oughton et al. 2003), and how nuclear accidents such as those at Chernobyl and Fukushima-Daichii are reported in the news media and interpreted in global energy policy contexts (Renzi et al. 2017, Hasegawa 2012, Joscow and Parsons 2012, Kim, Kim, and Kim 2013, Shrader-Frechette 2012, World Nuclear Association 2012, Wynne 1989, Gould 1990). Secondly, it concerns how energy prices, technological innovations, market mechanisms and other techno-economic phenomena

influence political decision-making (Greenhalgh and Azapagic 2009, Munro 2013, Sovacool and Valentine 2012, Markard and Truffer 2006, Adamantiades and Kessides 2009, Rubio-Varas and De la Torre 2017). Thirdly, it concerns how nuclear energy policy processes evolve within democratic systems through the actions of internal policy networks, regulatory bodies, and external actors such as industry organisations, lobby groups and environmental non-governmental organisations (Blowers and Pepper 1988, Carter 1989, Nowlin 2016, Jahn and Korolczuk 2012, Duffy 1997, Sovacool and Valentine 2012) and how practices of social engagement with social, psychological and ethical dimensions through participatory-deliberative decision-making influence policy outcomes (Espluga et al. 2018, Johnstone 2014, Whitton et al. 2016, Warburton 2009, Cotton 2017, 2009, O'Connor and van den Hove 2001, Whitton et al. 2015, Konrad et al. 2018, Atherton 2001).

One of the major driving forces behind the development of new nuclear build across the world is the urgent issue of anthropogenic climate change. The rapid decarbonisation of electricity systems is the key energy policy priority within Europe: across the Member States there is deliberation about the role that nuclear power might play within this (Bern and Winkel 2013, Bickerstaff et al. 2008). One of the key concepts that has emerged is the so-called reluctant acceptance (Bickerstaff et al. 2008) of nuclear power to resolve climate change given the aforementioned sociocultural barriers arising from negative socio-economic and perceptual issues that commonly emerge within civil society. Reluctance is described as a sense within policy networks that progress on developing nuclear energy will be slow and expensive due to public opposition, environmental regulation and externalities such as waste and decommissioning costs, but nevertheless the urgency of decarbonising electricity systems to meet legally binding greenhouse gas emission (GHG) reduction targets forces such a move. Understanding how these twin aspects of “reluctance” and “renaissance” play out in the development of nuclear power as a global sociotechnical system is, therefore, a key area of futures research, and one that we address within this report.

Typologies of future studies research

The discipline of futures studies is heterogeneous. In the early 20th century, HG Wells used the term *foresight* to describe and analyse the patterns of stability and change that would emerge within technological societies. The concept of strategic foresight defined this early field. Sometimes the term *futurology* is used to describe this kind of futures thinking, though the term has fallen away as few now regard it as a pure science.

Futures studies can be defined in relation to three problems. The first is to examine either possible, probable, or preferable futures, including futures that

are utopian, dystopian, or 'wild card' (characterized as a low probability high impact events) and the conditions under which these might arrive. The second is to gain a broad, systemic and holistic view of futures based upon an interdisciplinary evaluation of multiple academic disciplines. Third, future studies can unpack the assumptions that drive dominant and contending views of the future (Masini 2006, Son 2015) - in the present case, to unpack the underlying sociotechnical dimensions of a nuclear-powered future.

In order to engage in futures research one must first ask what kind of knowledge about the future is most needed (Dreborg 1996)? In the mid 20th century in the United States, futures studies as a discipline emerged primarily from military strategy during the Cold War. For example, the Society for General Systems Research in the 1950s and the RAND Corporation in the 1960s, were influential in bringing future studies to the analysis of major policy problems. Within the United States at this time, the focus was primarily upon applied projects, and upon the application of quantitative tools and systems analysis techniques. In Europe, by contrast, there was a preference for investigating the long-range future of humanity with regards to ecological limits, in essence, asking what future humankind had on Earth. Understanding the environmental futures therefore involves understanding symbolic and semantic representations as well as the physical resources available. By the 1960s there was an increasing influence of academic social science, philosophy, science fiction and artistic representation, which began to explore future scenarios and to fashion a common dialogue amongst future studies researchers.

By the 1970s there was a clear shift within the discipline towards the use of future studies in fields beyond military applications - looking at a wide range of technological, social and environmental issues. Problems such as population growth, resource availability, energy security, climate change, global poverty, biodiversity loss (etc.) came to widespread public attention with the publication of *Limits To Growth* sponsored by the Club of Rome (Meadows et al. 1972). The limits to growth research details computer simulations of the future based upon economic and population growth statistics and conceptualised future scenarios based upon this. It is important to note therefore that since the late 1970s, futures studies methodologies have incorporated quantitative, qualitative and normative ethical elements, and these are treated as mutually reinforcing components of futures thinking. Contemporary futures studies literatures are therefore concerned with the balancing of competing paradigms and intellectual frameworks, qualitative and quantitative methodologies, and synthesising pragmatic (and politically useful) lines of evidence upon which to plan industrial and environmental policy strategies (Slaughter, Inayatullah, and Ramos 2005, Sardar 1999, Dator 2002).

Probability and predictability

Within the natural sciences some systems are highly predictable and can be represented by mathematical models with a high degree of accuracy. However, not all physical processes (and certainly few social processes) are easy to predict in this manner. Chaos theory, stochastic analysis, and nonlinear science deal specifically with "unpredictability" in scientific reasoning. When it comes to thinking about long-term futures, there is controversy within the futures studies literature. Some believe that as science advances, particularly with the development of high-powered computing, algorithmic reliability and artificial intelligence, we will continue to improve our understanding of probable futures - in essence we will build better predictive models as we can draw more and more elements of complexity into a calculable form. Others argue, however, that the future is essentially unpredictable and that the best way to predict the future is to create it (Bibri 2018, Dreborg 1996, Quist, Thissen, and Vergragt 2011).

Methodologically, within the futures studies literature, predicting the future is usually through some form of forecasting analysis. Forecasting extrapolates present technological, economic or social trends and tries to predict what the future trend will be over a given timeframe. Such techniques have value when looking at individual components within a complex system. For example, when looking at trends in a particular commodity price, or trends in inflation or interest rates, forecasting such changes based upon an understanding of past changes under similar conditions has considerable value. However, forecasting is less valuable for the examination of sociotechnical systems under conditions of uncertainty. This is because the interrelationship between competing trends often renders the analysis too 'noisy' and hence ineffective as a decision-making tool (Giljum et al. 2008, Coates et al. 2001).

The discipline of future studies has come to use *scenarios* in response to the limitations of forecasts. A scenario is a possible future rather than a predicted future. The practice of scenario development facilitates research into competing worldviews and assumptions. One method is the so-called Causal Layered Analysis (CLA) method, which involves the creation of prophetic visions of the future and then examines how the present can connect with that future (Inayatullah 1998). CLA works by identifying the different layers of how a future is created. These include social, psychological, discursive, metaphorical, economic, environmental, political, resource use, and population layers of the future (amongst others). The method then seeks to synchronise these layers in order to create a coherent sense of what the new future might be. To connect that future to the past and present requires other methods, amongst which *backcasting* analysis is one of the most prominent (Quist 2007).

In work package five we employ the concept of backcasting in the examination of nuclear engagement futures - in essence, using the method to better understand the development of nuclear power as a sociotechnical system over time. The backcasting approach involves setting policy goals and then determining how those goals might be met. As Dreborg (1996) asserts, backcasting utilises a teleological understanding of social systems that doesn't rely upon causal thinking, while forecasting relies entirely on causal analysis, at least when interpreted as predictive methodology. Backcasting is a methodological tool to examine the complexity of nuclear engagement futures by projecting desired futures and then working backwards towards the present to imagine how they might be realised. Backcasting was selected due primarily to its problem-solving characteristics; more precisely, we adopt the *pluralist* or *participatory* backcasting approach (Robinson et al. 2011, Quist, Thissen, and Vergragt 2011, Tuominen et al. 2014), which differs from the more common think-tank approach (which involves main futures work carried out by a research group rather than a stakeholder group usually conducted using Delphi or other expert-elicitation methods (Robinson 1990, Carlsson-Kanyama et al. 2008), in line with HoNESt's emphasis upon co-produced, stakeholder-led problem framing and resolution concurrent with the ethos of HoNESt as a participatory research programme (Jasanoff 2004, Brugnach and Ingram 2012).

Backcasting

The concept of backcasting emerged in the work of Robinson (1982), who was interested in the literature on so-called soft energy policy paths. Writing in the 1980s, Robinson was concerned that energy policy analysis was dominated by forecasting techniques that extrapolated the economic performance of current technologies into the future. With rising concerns over the sustainable development of energy systems, the concept of the soft energy path - which considers measures such as energy demand reduction and alternative technologies (specifically renewables) - became increasingly desirable. Yet whilst there was a growing potential for 'soft energy' policy paths, it remained difficult to illustrate how to achieve them using conventional forecasting techniques. This lead to the development and growth in energy backcasting analyses.

Scenarios tend to be either 'probable' (i.e. most likely to happen in participants' opinions), 'possible' (but not likely) or 'preferable' (most desirable or ethical) future when designing a backcasting approach. The first two are *explorative* and last is *normative*, respectively. Explorative scenarios show what could happen (and in this case what participants thought was likely to happen) and normative scenarios show how a solution to a particular problem should look, from the participants' own personal point of view (Börjeson et al. 2006). The principle

underlying the backcasting approach in D5.3 is fundamentally normative rather than explorative – the future is desired and imagined and then the practical steps to implement that future are assessed (Cotton 2013, de Oliveira Musse et al. 2018). Backcasting is fundamentally normative in the sense that it is concerned with not only describing what the future looks like, but in providing an evaluation of that future.

Bibri (2018) argues that the backcasting approach is well-suited for finding long-term sustainability solutions due to its normative, goal-oriented, and problem-solving character. Backcasting allows visionary images of futures at different temporal scales, and this can stimulate an accelerated movement towards achieving such normative goals. Such normative reasoning is indicative of a certain type of judgemental evaluation - whereby some actions or outcomes are classed as good, desirable, or permissible, and conversely others are bad, undesirable or impermissible. Therefore, the normative propositions presented within the backcasting workshops are fundamentally evaluative. Normativity should be understood in this context, as Parfit (1984) argues, as claims about the reasons for action. For example, we have reasons to believe something, to do something, to have specific desires, aims, attitudes and emotions. We are motivated to take certain actions, but how we justify one course of action or another is based upon personal evaluation of the quality of that action and its outcomes. Backcasting workshops are intended to stimulate this type of thinking amongst participants - the aim being to get them to evaluate the future and justify their reasons for doing so during ongoing facilitated deliberation.

Backcasting methods

The methods used during D5.3 represent a *deliberative experiment* (see for example Grönlund, Setälä, and Herne 2010) in backcasting methodology development. We designed the methodology to be consonant with the focus upon nuclear engagement *history,* and wanted to harness historical thinking in the imagination of nuclear engagement futures. The reasoning for this is that imagining the future is both practically difficult and cognitively taxing (Levin 2004, Trope and Liberman 2010). Predicting long-term futures is difficult, in part because the quickening pace of societal and technological change over the last 50 years has meant that the past is not always a reliable yardstick for predicting the future (Green et al. 2002). Individuals - though fully capable of thinking about the future - are influenced by the past, by remote locations, other people's perspectives, and counterfactual alternatives in the imagination of such futures, and as such to imagine the future individuals must traverse psychological distance (Trope and Liberman 2010). Such psychological distance takes a reference point as *the self in the here and now*, and the distance might be the different ways in which an object might be removed from that point—in time, in space, in social distance, and in hypotheticality. Tope and Liberman (ibid.)

argue that imagining the future entails mental *construal*, and the farther removed an object is from direct experience, the higher (more abstract) the level of construal of that object. It is therefore necessary to try to anchor the imagination of the future by participants in concrete ways.

As a methodological design point, we focus on three ways in which this might be achieved – firstly by anchoring understanding of the future in an assessment of the past, secondly by comparing what participants think is likely to occur in the future (exploratory scenarios) with what they believe to be desirable (normative scenarios), and thirdly by limiting the timeframe across which they imagine such futures – i.e. by focusing upon short-term timeframes of around two decades into the future (which is considered "reasonable" given these mental constraints Tonn, Hemrick, and Conrad 2006).

The backcasting approach takes place in the context of deliberative research. Deliberative research brings together members of the public with key civil society stakeholders from industry, journalism, regulatory agencies, non-governmental organisations, lobby groups and scientific institutions (Abelson et al. 2003, Burkhalter, Gastil, and Kelshaw 2002). A deliberative workshop is a mode of qualitative enquiry that is widely employed in northern Europe (Chilvers 2010, Bohman 2000, Webler 1998). In essence, it is a facilitated conversation on a topic that may be familiar to some - but not all - participants. A deliberative workshop differs from a focus group in a number of ways. Focus groups present a series of questions followed by unstructured discussion amongst a small group of individuals. Such methods are useful for gaining feedback on proposals, gauging public attitudes, or reacting to specific propositions. However, focus groups tend to encourage participants to express top of the mind opinions and immediate reactions (Krueger 2000). Deliberation, by contrast, goes to a greater depth with strong interaction over time. In a deliberative workshop the emphasis is upon facilitated dialogue and argumentation structured around specific tasks, which encourage active listening and social learning (Steyaert et al. 2007, Blackmore, Ison, and Jiggins 2007, Tippett et al. 2005).

Participants are encouraged to listen and react to the propositions of other participants within a group, necessitating active facilitation by a trained facilitator (Clarke, Blackman, and Carter 2004, Frey 1995). Deliberation is based upon Habermas's (1984) concept of ideal speech - whereby the rationality of arguments presented is a key criterion of success (see also Webler 1995). In the discussion of futures, facilitated dialogue aims to explore the differences between competing stakeholder interests but also common ground. The aim is not to create a single unified consensus, but rather to explore differences and identify any areas of natural consensus. In deliberative group activities facilitators must be mindful of social psychological effects that might limit the validity of the resulting qualitative data. These include groupthink (a bias

whereby outlying or contradictory positions are minimised or excluded), false consensus (where agreement masks social and philosophical divisions within the group), 'social loafing' (whereby individuals perform less work in a group than they would alone), 'group polarization' (decisions are made that are more extreme than the initial inclination of its members) and 'escalation of commitment' (where a group faces increasingly negative outcomes from an action but nevertheless continues the same behaviour rather than alter course) (Mannion and Thompson 2014). Managing these pitfalls is only possible with skilled facilitation. Moreover, the structuring of workshop methods and activities is paramount. To confirm the successful implementation of the workshops, an evaluation questionnaire was developed for completion by participants; the nature of the questionnaire, its rationale, and the results from this, are reported after the data analysis in Part 4.

Sampling, reliability and validity

The participatory process for data collection took the form of three deliberative workshops, held in Barcelona (September 2017), London (January 2018) and Munich (April 2018). The geographic focus differed in each case (Barcelona – nuclear power and civil society engagement in Southern Europe; London – northern Europe; Munich – Eastern Europe). Note that the focus of the discussions was participant-led, so country-specific perspectives were not predefined by the facilitators. Participants in the workshops were encouraged to bring in examples from their own experience and expertise regardless of the national case study context. In our workshops, we combined a strategic sampling approach combined with voluntary self-selection. We had a long list of nuclear industry stakeholders produced by the HoNESt partner organization SPI. We also used stakeholder networks from within the HoNESt program, and through searches of professional databases. Invitations were also sent out on social media, and citizen-stakeholders were invited to attend workshops in London and Munich through the use of Eventbrite – an event listing tool open to the public.

Participants are kept anonymous, and utterances described in the analysis are unattributed (so-called Chatham House rules). However, a list of participating organisations in each workshop is included below:

Barcelona

- ZERO – Portugal
- OECD – France
- Universidad Pública de Navarra – Spain

- SNE – Spain
- Kings College London
- EDF

London

- National Nuclear Laboratories (four participants) – Scientific institutions – UK
- 10 x Universities (Open, UCL, Sussex, Queen Mary, Imperial, Birkbeck, Cambridge, University of Highlands and Islands)
- OECD
- Energy for Humanity
- Wood Plc.
- European Commission
- Innuserv
- Euronuclear
- Compelo
- SckCen
- So Ethical Media
- 10 x unaffiliated citizen stakeholders

Munich

- Universities (TU Munich, KIT, Zeppelin University, Ecole Polytechnique Fédérale de Lausanne (EPFL))
- JRC
- Journalistin
- European Commission
- CEA
- EON/ Deutsches Atomforum
- Innuserv
- TU Munich
- KIT
- BfS
- Areva
- Greencross
- Department of Nuclear Energy Hungary
- Deutsches Atomforum
- Mothers Against Nuclear Power
- Unaffiliated Citizen stakeholders (3 participants)

We make no claims to demographic representation within the workshops. As with any other research within a post-positivist paradigm, the aim is to provide

an in-depth perspective upon the problem at hand using rich descriptive data, rather than aggregating top-of-the-mind perspectives in the manner of a quantitative social survey. In quantitative social science research, validity and representativeness are common evaluative tools for measuring the success of research outcomes. These are representative of a positivist social ontology, much like that of the natural sciences. Yet reliability and validity used in quantitative research should be redefined for their use in naturalistic settings such as those in the deliberative workshops, and Golafshani (2003) suggests that these can be reinterpreted as *trustworthiness*, *rigour* and *quality* within a qualitative paradigm. This means that the evaluation of the qualitative research is based on whether the analysis is representative of the discourse that emerges from group interaction, whether the theoretical insights emerging from the analysis are epistemologically grounded, and whether the recommendations made are suitably justified in light of the other two criteria.

Conceptual framework and data analysis

The data produced within the workshops combines a range of written, drawn and spoken elements. Collectively we can refer to this as qualitative data - in the sense that what is produced has no numerical value, but rather provides rich descriptive data about how individuals conceptualise and deliberate upon the issue of nuclear engagement futures across different national contexts.

The conceptual framework through which the qualitative data is interpreted is that of *symbolic interactionism*. Symbolic interactionism is a social scientific theory concerned with how individuals utilize information, construct images and create symbolic worlds in order to communicate with one another. At its heart, symbolic interactionism suggests that people create shared meanings through their interactions, and those meanings become their reality (Charon and Cahill 1979). As a conceptual framework, at the macro-scale this helps us to understand how society Is socially constructive through repeated interactions between individuals (Alver and Caglar 2015, Solomon 1983). At the micro-scale of these workshops, symbolic interaction helps us to understand the shared understanding and interpretation of meaning that emerged within the interactions between participants. According to the symbolic interactionist conceptual framework, meanings become modified through an interpretive process used by the person in dealing with phenomena that he or she encounters (Blumer 1986, Snow 2001). Analysis of interaction and behaviour is framed through the shared meaning attached to findings. In the workshops, we employed a range of dialogue, drawing and voting procedures (discussed below in the methodology section). Within the symbolic interactionist framework, the drawings, writing and discussions become windows into a “common set of symbols and understandings” (Patton 1990) which are shared amongst

workshop participants, and thus become “co-constructed” - their meaning is ascribed through interaction.

In practice, all workshops were audio recorded, and all writings, drawings, and votes were recorded and photographed to form the primary data for analysis. Data analysis follows a constructivist paradigm, with thematic coding of workshop responses (Charmaz 2000, Boyatzis 1998, Braun and Clarke 2006). When coding transcripts of audio recorded data, thematic codes are commonly constructed *in vivo* “from the bottom-up” through reading and analysing specific utterances. However, in the workshops the discussions were framed and guided by the written and drawn material. The conversations were mapped out visually, and so a bottom-up approach is unnecessary. The drawn images were used as a guiding framework to structure the thematic analysis, in a manner similar to other qualitative analyses of deliberative workshop data (for example Chambers 2002, Burgess et al. 2007, Cotton 2014, Partridge et al. 2017, Ipsos MORI Research Institute 2013).

Due to the nature of the dialogue, how the workshops were structured, and the diversity of participant interests at stake, reporting of utterances within the workshops follows so called Chatham House rules. This means that utterances are contextualized by the workshop session and the task, though they are not attributed to specific individuals. This allows anonymization, encouraging free-flowing dialogue. It also encourages shared group response to the problem task, reducing stakeholder conflict and minimizing reputational harm to participants.

Workshop methods in practice

In each case, the workshops were designed to identify 5 individual elements of nuclear engagement futures:

1) To imagine and identify key characteristics of nuclear engagement histories for the respective geographic region
2) To predict likely engagement futures
3) To identify and delineate desirable engagement futures
4) To analyse the steps required to achieve these futures
5) To present potential policy/practice recommendations for achieving desirable futures.

To operationalise this approach, we utilised 3 methods:

1) The River of Life methodology for examining nuclear engagement histories
2) A backcasting method
3) Dotmocracy™ for policy perspectives.

In each case we give examples of the method and some initial indicative findings from the empirical data collected in the workshops themselves.

Part 1. The River of Life

The River of Life method is a visual narrative method used in participatory planning practice to help participants to discuss the past, present and future of a project, idea or process. The aim is to build a shared view compiled from differing stakeholder perspectives. Methodologically, the River of Life method is similar to the *shared life histories* method (Hope and S. 1994) used in participatory action research: it is a group facilitation technique that uses visual narratives to help people tell stories of the past, present and future. The method is set up as a facilitated dialogue session, i.e. a small group of participants discuss the proposal in a focus-group style setting. However, unlike a traditional focus group, the facilitator encourages the participants to imagine the project or proposal as *river*. Participants then articulate their perspectives on the proposal using visual metaphors pertaining to water. These could be the surrounding landscape, different types of water bodies (lakes, canals, tributaries, dams, waterfalls etc.), or systems/objects such as dams or boats. For example, a river could be drawn with channels “branching-out” if two different technologies were developed at a particular time, or if there was a change of government and a change of policy. Alternatively, tributaries could be used to join a main river to show where different ideas become popular and part of ‘the mainstream’. Other features like lakes created dead ends, such as when a policy failed or a technology was replaced by a more efficient design.

The major events and milestones in the lives of (in this case) nuclear energy projects are placed into the narrative of the river to give it structure and to provide a chronology. Through group visualization the river becomes a tool to guide deliberation, allowing participants to capture the milestones, failures and successes of a project, idea or technology over time (Fisher and White 2018).

In practical terms in the workshops we set up the River of Life on a large roll of paper (landscape oriented) mounted on a wall. Post-it notes and different coloured pens were used to make the river-shaped diagram that formed the focus of discussions. There was digital audio recording for each discussion.

The cohort of each workshop was broken up into groups of around 8 participants (Barcelona - 2 groups, London – 3 groups, Munich - 2 groups), with each group guided by two facilitators.

At each point, we asked participants to consider:

- How are different people or groups of people involved in decisions about nuclear power?
    - Who is included and who is excluded, and why?
- How are decisions made about nuclear power?
    - What decision-making processes are used, and why?
- How have these things shaped the development of the nuclear industry over time?

In the workshops two facilitators were ascribed to each group (one guiding the discussion the other taking notes, helping with recording and practical matters). One facilitator took primary control of the drawing process with suggestions and amendments along the way from participants such that the discussions were participant-led. The river mapped out the conversation that the participants took part in along the way, and participants had opportunities to challenge, change or agree the ways in which the river was shaped, the visual metaphor features deployed, and the milestones that were stuck on (using sticky notes). In the Munich workshops these were added at the start, but in the other sessions in London and Barcelona, they were added in along the way. Milestones included new policies, changes of direction, or key events that influenced the development of the nuclear industry. An example river from the Barcelona workshop is shown in Figure 1.

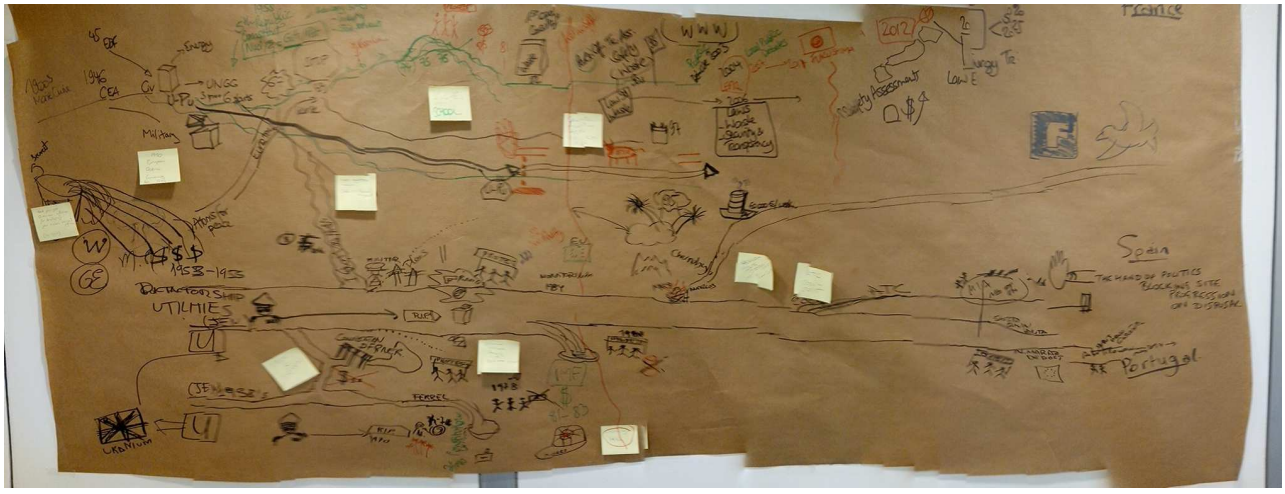

Figure 1 An Example River of Life

Part 2. Backcasting ideal nuclear engagement futures

In this second session, participants aimed to project their idea of an *ideal* future for engagement with nuclear energy and society. This involves various components, firstly an understanding and articulation of their ideas of what an engagement future is, how likely and predicted futures differ from their ideal scenario, what features their ideal scenario has, and crucially*, why* is it ideal from their perspective? To break this down, we divided the backcasting session into two parts. First, participants are asked to imagine what is *likely* to happen, and then second what each participant *wants* to happen.

We set a nominal end-point of 2050 for the projected backcasted futures, though discussions over nuclear waste management commonly extended beyond that period, and we placed no absolute limit on what future could be discussed.

In the different workshops, we experimented with slight variations on the methods deployed. In Barcelona, we used the River of Life and extended it into the future through group discussion, which was then annotated with post-it notes on ideal futures and then these were grouped together. However, in London and Munich we switched this slightly based upon feedback from the first Barcelona workshop, and gave each participant a few post-it notes, asking them to individually and privately write down what their ideal nuclear engagement future looks like. This latter method proved very effective. At all times, we asked them to consider in the construction of the futures:

- How are different people or groups of people involved in decisions about nuclear power
    - Who is included and who is excluded, and why?
- How are decisions made about nuclear power?
    - What decision-making processes are used, and why?
- How will these things shape the development of the nuclear industry in the future?

The facilitator then groups the notes together into a collective set where ideas presented are similar or related.

These are then grouped and labelled as the ideal futures and put up on individual sheets at the far end (on the right) of a long sheet.

As mentioned above, backcasting is a process of taking the imagined futures that are desirable and working backwards (in this case from right to left across a broad sheet of paper) starting with the ideal future and then moving backwards towards the present. Of the ideal features presented participants could choose

to discuss any of them (this was facilitator guided). Using a model similar to that described by Mitchell and White (2003), we asked participants to consider three elements:

- ***Actions*** – e.g. new policies, new designs or technologies, ideas, protests, anything that people can do to make the ideal future happen.
- ***Actors*** - i.e. individuals (inventors, politicians, representatives of non-governmental or civil society organisations), or organisations with a specific purpose, like government departments, companies or charities.
- ***Assumptions*** – these are the contextual factors that influence what actors can and can't do, and how they do it. For example, these could be assumptions about the state of the economy, about the availability of certain resources, the political climate in which decisions are taken, etc.

The links between these three elements were presented to the participants in a linear fashion (as shown below in Figure X), but the facilitators were clear that their output would likely be messier than this. The aim was to put together these different elements in a way that helped participants to think about the problem over time rather than trying to make a neat-looking diagram.

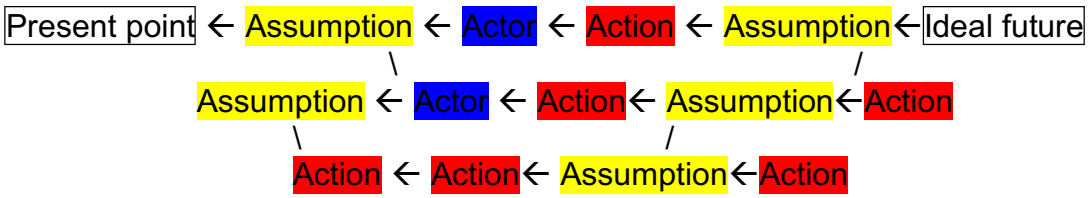

Figure 2 Diagrammatic representation of backcasting

By discussing the interrelated elements of actors, actions and assumptions, the participants construct a concept diagram that moved chronologically backwards from future to present. When the present is reached for each of the ideal futures identified then the process is concluded.

Part 3. Action planning and reflection

The final task was a small group-facilitated discussion using an approach to start action planning for implementing the backcasted visions of ideal nuclear engagement futures. The participants were instructed to discuss in small groups what actions the identified actors in the backcasting method *should* take to make specific ideal futures happen, based upon the actions and assumptions listed for each and to rate one another's ideas using a specific format. The process was finalised by distilling the actions, actors and assumptions from the previous session into an action plan – a strategy that *should* be put into place to start the process of achieving the desired end state.

Participants were instructed to look at the actions, actors and assumptions closest to the present. We then asked them to question "How can we start and then sustain a process that leads to your ideal future?"

The last session used a method commonly referred to as Dotmocracy (TM) or Idea rating sheets, shown in Figure _. Dotmocracy is a facilitation method used to describe voting with dot stickers or marks with a marker pen (sometimes called dot-voting). In dot-voting participants voted on their chosen options using a limited number marks with pens to create a form of cumulative voting (Diceman 2014).

In practice, a series of sheets were put on tables. Individuals were instructed to write potential plans, strategies or actions that could be taken by different stakeholders. These were then put around the room and participants was instructed to 'vote' on them by marking approval or disapproval of the idea on the sheet – thus giving us some indication of the desirability of these actions. The signatures on the side were optional, but they allow us to know 'who thinks what' – i.e. what preferences different stakeholders within the workshops had.

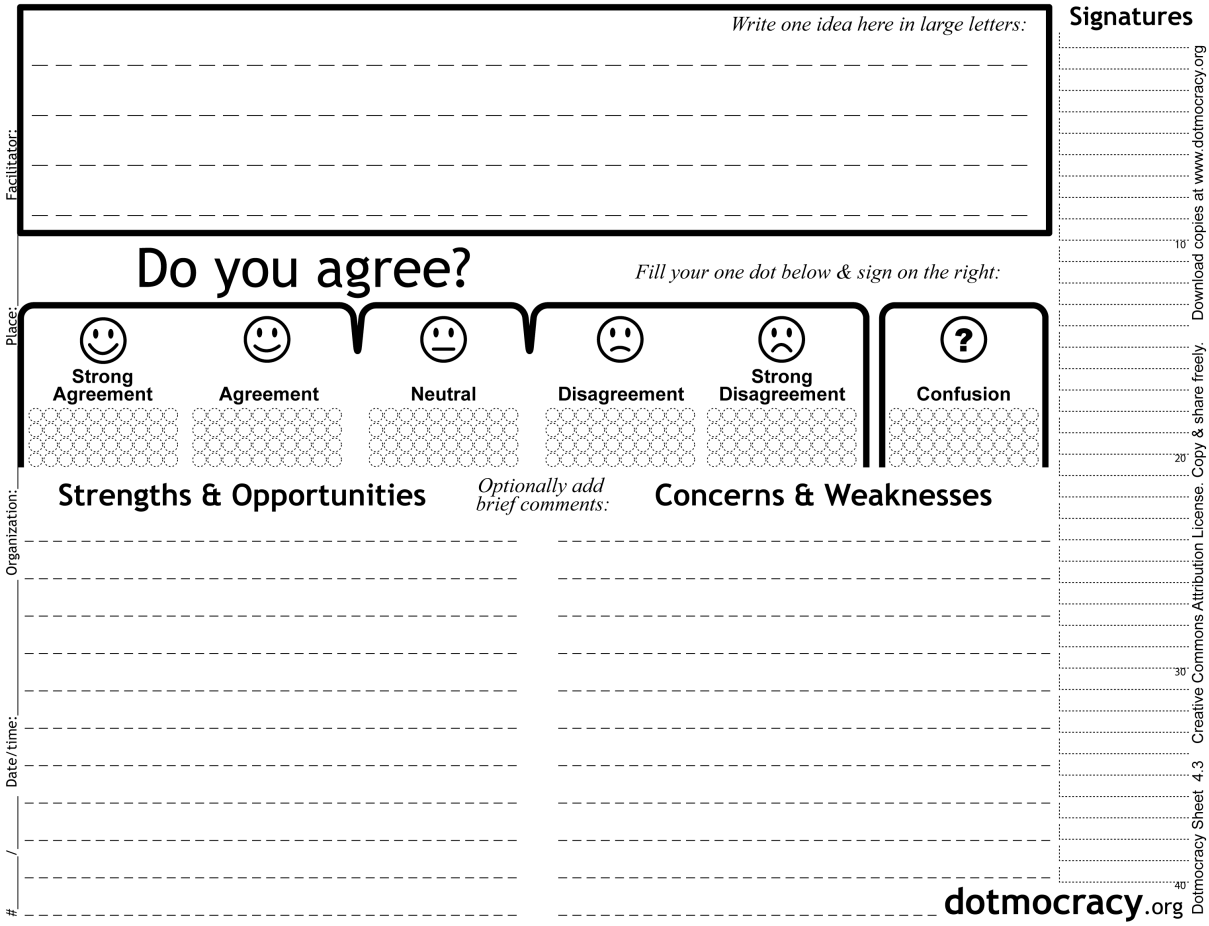

Figure 3 A Dotmocracy™ sheet

The Dotmocracy™ method has a number of advantages. It's less cognitively demanding than having to perform a full ranking of all the options, because participants are not required to give a comparative judgment of each option, and it allows participants to express a preference for more than one option at the same time. It also leverages the collective wisdom of the team, and provides an equal way for all the voices on the team to be heard and have accountability in prioritizing key issues, and finally it creates a sense of engagement and allows participants to see the decision process in action and understand how the final choice was made (Diceman 2014). This has specific value in 'closing down' the sessions on futures as it provides a set of clear actions, future directions for research and policy, and some basic evaluation of their popularity amongst participants.

Results

Results are discussed through thematic analysis of symbolic representations emergent within group discussions (Boyatzis 1998, Braun and Clarke 2006). The aim in this section is to identify commonalities of thinking and social *imagining* of the histories and futures of nuclear energy and society and to discuss potential differences amongst them (with a particular emphasis on country-specific differences that contextualize the findings within the pan-European project). The analysis is therefore structured into three sections, and each is subdivided to compare between the three workshops, as well as between individual stakeholder groups within each workshop:

1. Imagined histories
2. Backcasted futures
3. Planning and policy making for nuclear engagement futures

Part 1 – The River of Life findings

Background

The River of Life method is designed to draw upon the memories of individuals, and then weave them together into a coherent narrative about how nuclear engagement histories unfolded. It must be noted that this focus upon the social scientific study of participant imagining of the past is grounded in an understanding of *memory*. Memory is an integral part of the mental functioning of individuals and is closely linked to cognitive processes of personality construction and selfhood (Singer and Salovey 2010, Yang 2013). But individual or personal memory is also a part of the cognitive processes that allows human beings to function in social settings. As Cubitt (2013) argues, its forms are influenced by its social uses, and it makes a contribution to social knowledge and social understanding that can be explored from a group as well as an individual angle. Memory is therefore a resource both for individuals within society and for societies themselves and how it is connected to larger social processes. The term *memory* is used here in the sense that the information gleaned within the workshops is located first within the minds of individuals, and then constructed (collectively) through a process of facilitated dialogue, and interpreted by individuals in such a way that they can draw meaning from what is said, shape the dialogue that surrounds discussion of the historical facts and proffer their own interpretation. The emphasis in the analysis is upon *memory* and its relationship to *framing* (Barthe 2009, Tversky and Kahneman 1981, Frisch 1993, Clarke et al. 2015, Kahneman and Tversky 1984) – how specific

attributes, events, and interpretations are emphasized over others. There is no single version of events to which all participants in the workshops will ascribe; rather, different stakeholder actors emphasise different elements in order to construct their own narrative about what is important, which events are discussed, and how they *should* be interpreted (in a normative sense).

We conduct the analysis of framing as a matter of symbolic interaction rather than *historical analysis* per se. We are interested in how individuals draw upon and then socially construct knowledge of things that fall within their personal and professional experience – the biases and heuristics that they employ in their interpretations are not judged or corrected. Our analysis is distinct from *history* as an academic discipline employed in Work package 2. Historical analysis draws upon multiple lines of evidence through which to deduce knowledge of past circumstances (Carr 2018, Lemon 2002).

Our social scientific analysis uses the workshop products as representations of *social memory* – we examine how individual representations of nuclear energy and society are morphed into understandings and senses of the past which are then reproduced through group dialogue, story-telling, metaphors, and visual representations. The aim within the River of Life sessions is not to challenge the accuracy of these social memories in comparison with the historical record. Rather, the aim is to explore through symbolic interactionist analysis how broader ideas of technological development over time are *perceived*, *imagined* and *socially constructed* in dialogue and through drawn images (including visual metaphors). It is important to note, therefore, that what is important is *what is emphasised and imagined* by participants, not what is *right or contestable,* when discussing nuclear engagement histories. In short, it doesn't matter if the facts contained within a line of argument are wrong, what matters is that the participants choose to emphasise such lines of argument over others.

The analysis draws upon the very broad geographical spread covered within the workshops. Discussions amongst participants encompass multiple national histories, political structures, financial and resource geographies, technology development programmes and innovations, and numerous political actors. As such, the information discussed in the workshops is subject to *interpretive flexibility* (Pinch and Bijker 1984, Bijker, Hughes, and Pinch 1987) different actors will employ different values and 'frames' (Kahneman and Tversky 1984) in their understanding and discussion. This can be summarised as one participant stated:

> "The details are very complex; the primary source material is often secret and often subject to interpretation." (London, Group 2).

The aim is not to describe the perceptions of each of the complex national histories here, but rather to describe and assess emergent commonalities in the

way in which *nuclear engagement* is framed. We aim to assess through qualitative analysis of the written and spoken data to show how the exchange of meaning in the workshops through language and symbols (Blumer 1986) helps the participants to make sense of the nuclear engagement phenomenon. We present these dominant frames and by grouping them under a series of thematic subheadings.

Structure and agency, stability and change

Within the social sciences is a core meta-theoretical question about the role of structure and agency and shaping social conditions and the actions of free-willed agents, and how this related to the issue of stability and change in dynamic social processes. Structure is defined as a set of constraining conditions: in this context we can understand these as including (but not limited to) material resource constraints. These include issues such as the availability of fossil fuels, the presence of coastal locations for some reactor types (as is the case of any thermal power station that requires abundant coolant water), or the broader political or ideological conditions that shape certain innovation and technology development actions and not others. Social structure is not simply about physical resources but also cultural resources including political ideologies, norms and social rules. Agency, by contrast, describes the actions of free-willed individuals to meet their own needs and have influence upon the world around them. In this context, we might understand agency as the capacity of innovators, politicians, or civil society organisations such as protests groups, to influence these structural conditions. In work package 4 of HoNESt these groups are defined as *stakeholders* (under categories including regulators, promoters, and so on), and this terminology is useful in simplifying what is meant by *agents* in this context. The key point to emphasise is that we can understand structure and agency as having a *dialectical* relationship – in the sense that certain constraints enable particular actions and discourage others, but where constraints are undesirable, agents strategise, learn from past actions and work collectively to overcome them. The application of agency then changes the social landscape in which action can be taken, and thus creates a new set of social constraints (it reforms social structure). In the context of nuclear energy and society, we can understand this dialectical relationship as an iterative and cyclical process of socio-technical system development over time (Sewell Jr 1992, Archer 2003, Giddens 1986, Hay 1995, Cotton 2015, Jessop 2005) – certain decisions and actions open up new options and close down others, and discussing these facets is the core purpose of the analysis.

If we take structure-agency as a starting point, this in turn, relates to stability/continuity (the features of the social world that remain constant) and change (those that alter either incrementally over longer periods or radically

within a shorter time frame) (Meijerink 2005, Streeck and Thelen 2005, Pettigrew 2013). The concept of 'punctuated equilibrium' is familiar to the social sciences when discussing processes of change, as it defines a dialectical relationship between structure and agency, and between stability and change over time.

There are different models of change commonly presented in the social sciences, though these tend to fall into three categories: incremental, revolutionary or punctuated equlibrium. Incremental changes are represented by a series of small steps. Change occurs only as a result of bargaining between partisan interests, and so bigger "heroic" changes are rare. In the incremental model, policy-making processes occur as a matter of trial and error, and because partisan political parties are ever fluctuating and power shifting between different interests, genuine paradigmatic shifts within the policy landscape are suppressed (Cotton 2017, Hayes 2006). In the revolutionary model, there is an emphasis upon " critical junctures" - such as for example times of crisis: during these periods there is a rapid social change within a very short timeframe (Suddaby, Foster, and Mills 2014). The revolutionary model suggests that during crises, policy innovators will capture the narrative and push through rapid changes in the policy landscape. The third model is the punctuated equilibrium model which is more or less a hybrid of the other two (Gersick 1991). In *punctuated equilibrium*, long periods of incremental change are broken up by shorter periods of accelerated change at key points. Punctuated equilibrium is a popular explanation of social change amongst political scientists, due to its flexibility in describing a dialectical relationship between stability and change over time. We return to this concept in the analysis of the data.

Implicit within any discussion of history within the workshops are these two dialectical meta-theoretical features – the role of agents and institutions in constraining or enabling particular actions, and how this results in periods of slow or rapid change in the nuclear policy landscape of the respective countries. What is notable in the context of the River of Life method, is that these dialectical relationships are implicitly *drawn* and discussed – the visual metaphors of water courses (rivers, streams, lakes etc.) become representative of stability and change within socio-technical systems, and the annotations to these water courses and the milestones they were asked to place on the drawings (including other visual metaphors, cartoons, slogans, logos, stick figures etc.) show how agents and technologies interact within these processes of change. In terms of how the concepts of nuclear energy and society are *symbolically* represented in the workshop discussion, these relationships between actors and institutions, change and continuity are very clearly (if implicitly) expressed.

When completing the analysis of the qualitative spoken and drawn data from this session of the three workshops, the first point to note is that there is a huge range of structure-agency relationships that emerge. Participants continually frame and reframe periods of stability and change within the nuclear-energy-and-society landscape across the different countries, trans-border regions and timeframes. Examples of these are discussed to illustrate the complexity and diversity of these relationships, though this cannot be fully comprehensive in terms of the level of detail for individual countries at specific periods of time; rather the broader thematic representations are of interest in this analysis because they serve to ground the later understanding of nuclear engagement futures expressed in subsequent sessions.

Findings

Structure and agency under different governance regimes

There are a number of key emergent structure-agency dialectical relationships as they relate to the question of nuclear energy and civil society *engagement* processes. The first concerns the role of political regimes in furthering energy policy goals that are either pro- or anti-nuclear at different periods in history. This is discussed primarily in terms of the differences between the democratic regimes of Western and northern Europe, and the United States, in comparison to the former socialist republics of Bulgaria, the Czech Republic, Hungary, and the former fascist states of Spain and Portugal. Primarily these are referred to in terms of democratic and authoritarian political regimes respectively. The second, involves the role of scientists, specific innovators and other key stakeholders to augment the structural constraints of particular political regimes, to engage with policy networks for nuclear energy, and directly with civil society organisations and affected publics. The third, involves the power of scientific and governmental advisory bodies, the knowledge produced by them and the resultant reporting of such knowledge as creating a *punctuated equilibrium* of nuclear energy policy development (this term is explained below). The fourth, concerns how engagement practices have been stimulated by the actions of social movements of opposition in response to the actions of government authorities.

The ‘top-level’ observation to the development of early nuclear energy programmes is that participants describe the development of nuclear technologies under the formally communist regimes of the Soviet Union, Warsaw Pact and Comecon countries (notably Bulgaria and East Germany and, to a lesser extent, Czechoslovakia/the Czech Republic, Hungary and Romania), and the formerly fascist political systems of Spain and Portugal in the mid-20th century, in very specific ways. One key finding that relates to the understanding of engagement in the context of authoritarian regimes is, in broad brush terms,

that participants view the development of such nuclear programmes in terms of individuals (often scientists) trying to navigate and augment a complex, resistant and indifferent political regime. Such regimes are driven by broader ideological concerns about national image, resource constraints in globalising fossil fuel markets, and soft power accumulation within a bi-polar global governance regime between East and West. In the democratic nations, specifically the United Kingdom, Belgium, Sweden, France (and latterly a reunified Germany), participants tended to define the actions of the state primarily in *agential* terms through the actions of innovators, pioneers, trusted experts, and military secret-keepers. Military and independent scientific and technical advisory bodies were argued to be the key players in shaping nuclear policy programmes through either secretive or technocratic means. These became progressively less 'secret' as policy making gave way to newer forms of participatory engagement and democratic renewal. Like the authoritarian regimes, democratic countries had similar pressures around resource scarcity and rapidly increasing fossil fuel prices (particularly in the context of the oil crisis of 1972-73), but approached nuclear technology development in slightly different terms - primarily around the soft power gained by scientific innovation, technology transfer and the marketization of nuclear expertise. This contrast between these two types of political regime is one of the key engagement contexts that emerged in the workshops.

Authoritarian and democratic influences upon nuclear energy engagements

In the workshops, there were representatives that spoke about former Soviet republics/members of Comecon and the Warsaw Pact within the sphere of Soviet influence (Czech Republic, Hungary and the former East Germany and the former People's Republic of Bulgaria). Understanding the role of nuclear energy within the USSR and its allies has political-structural, resource, and ideological components that are outlined below.

In general, we can categorise the socially constructed history of the USSR and other socialist republics presented in the workshops as an approach to nuclear technology development grounded in a range of underlying motivations and rationales. The first is experimentation with different types of energy technologies (lignite was mentioned for example) to combat power cuts and potential coal shortages across the Union. The USSR/Comecon was also perceived as concerned with building reactors that involved large-scale collective labour efforts – nuclear energy was argued to be desirable to the USSR/Comecon precisely because it involved mega-project construction which was highly technical and labour-intensive. This allowed socialist republic

officials to showcase the power of collective labour by building reactors so quickly (within 5 years). There were also broader resource constraints particularly around energy, access to energy markets, fuel transportation across the Soviet republics, electricity shortages, and concerns around the technological efficiency of broader industrial programmes that were discussed in detail, and these material constraints were powerful in shaping nuclear energy decisions.

In Bulgaria, for example, by the mid-1960s one participant discussed the role of power cuts in shaping nuclear energy technology choice. Specifically, this relates to the material conditions by which energy security concerns created political will for the development of nuclear power, though there were detractors within government that created opposition grounded upon the perception that "the technology was too young" (Barcelona group 2), and it is only after a period of political obduracy around nuclear decision-making (where little technology policy change occurred) did a nuclear programme emerge compared to other fossil fuel development programmes at the time. It was also noted that the push for nuclear energy was in part driven by a lack of efficiency in industrial sectors. There were very clear resource needs to fuel the industrial expansion of the socialist republics, and these were discussed heavily in the Barcelona and Munich workshops. Although there was an easing of fuel shortages over time, the inefficiency of some sectors like steel production (for example), drove rapid development to improve industrial capacity and energy efficiency within the socialist economic system (Barcelona Group 2). Yet in other cases (notably East Germany) in the immediate post Second World War era developments in coal extraction meant that immediate economic shortages were less of a concern compared to long-term planning for resource scarcity (what could be termed 'peak coal'). As one participant in the Munich workshop put it:

> "There was a lot of coal in the 1950s and 60s, so it was a prognosis for the future, that these resources would run out." (Munich group 2).

Resource scarcity was a common structural theme that framed discussion of all nuclear histories. The development of nuclear energy in the 1950s had a common thread across both the authoritarian and democratic nations discussed. A lot of this has to do with post-war reconstruction, the constraints placed by coal production, and the rapid period of economic growth that emerged in both capitalist and communist countries. In relation to countries such as Germany, there was discussion about:

> "The German economic wonder – the need for cheap energy and the trust in society for the technology was the main reasons for the stepping in for the use of nuclear power in the economy. There was a huge need for energy and this was one of the possibilities to get a bigger amount

> compared to the other sources of energy, and it was cheaper in the long-term perspective." (Munich group 2)

In short, the long-term economics of nuclear energy in the 1960s, and then the threats created by the Oil Crisis in the early 1970s were perceived as key motivating factors behind the expansion of nuclear during this period. It was clear from the workshop discussions that nuclear energy – from a historical perspective - can only be understood in relation to fossil fuel resource economics both in democratic and authoritarian regimes. Decisions were often made under conditions of long-term certainty over both resource availability in the short-term (due to price shocks from the oil crisis), and broader projections of resource scarcity from peak oil and peak coal.

The emphasis upon rapid industrial expansion is posited against a backdrop of growing international concern with sustainable development, with environmental justice, and the rise of green politics. The Barcelona and London workshops mentioned the club of Rome report: The Limits to Growth (Meadows et al. 1972), and the growing ecological movement that influenced green politics in Sweden, and later Germany. Green politics was not simply about representation of green parties in European parliaments (it was noted that in the UK for example, first past the post political systems precluded the rise of green politics in government), but also the development of new dedicated environment departments and explicit commitments to sustainable development within the national governments of the UK, Germany, France, and Sweden. These twin factors of highly volatile fossil fuel prices and new policy structures to manage long-term resource scarcity were perceived as instrumental in furthering the nuclear policy agendas of many different countries under consideration in these workshops.

In terms of engagement practice, there are a number of other political, sociological and ideational motivations (other than concerns over resource scarcity and price volatility) that lay behind different nuclear programmes. One common theme that was discussed, is the political desirability of atomic energy technology at the beginning of the Cold War period. What was remarked upon was, what we could term, the *soft power* afforded by becoming an atomic-energy wielding nation. For countries such as United Kingdom or the United States, the development of nuclear weapons and concurrent civilian nuclear energy programmes was described in a number of ways, for example:

> "[The UK] Keeping a seat at the top table" (London group 2).

> "The Atom is great, it makes us (the USA) a superpower" (London group 1).

This represents both hard and soft power in global politics. Having access to nuclear technologies gives the hard-military power of strategic and tactical nuclear weapons, but access to civilian nuclear energy also provides considerable soft power. The former is the ability of governments to influence global affairs by exercising military capabilities (a show of force), or economic capabilities (such as sanctions, trade deals etc.) to support their agenda. The latter is the capacity to influence decision-making both domestically and globally through diplomatic channels, through culture, language, and crucially for this context, through scientific advancement and technological transfer (Nye 1990, Nye Jr 2009). These last two are sometimes more accurately termed 'smart power' (Wilson III 2008). The role of domestic scientific and technological expertise, the development of reactor designs and, certainly in democratic nations, the capacity to trade those designs internationally, were perceived as a powerful draw for governments to invest in domestic nuclear industry capabilities in the 1960s, 70s and 80s. As technological programmes moved away from post-war reconstruction towards international competition, this in turn was driven by the prevailing technological optimism of this period. As one Munich workshop participant states:

> "It was economic development after the Second World War, this is similar in France and Great Britain, it was a future dominated by technology, the car became more accessible, people believed that they would have flying cars by the 1990s. It was a particular way of thinking." (Munich group 2).

The public zeitgeist was defined as a desire for a high-tech "space-age" lifestyle and government support to innovators to achieve this. This is conceptually a form of *technological optimism* (Basiago 1994, Salmon 1977) or *meliorism* – a sense that technological progress will reap social welfare benefits in a progressive and linear fashion.

There was, in the context of authoritarian regimes, a perceived desire not just for technological advancement, but for social solidarity building across national borders (in the case of the former Soviet republics to cement their position within the USSR, and to showcase domestically the power of collective labour):

> "They took the decisions – they made it ideological because there were 10,000 people building in 1964. The first reactor was put by Soviet operators, and the second was Bulgarian" (Barcelona group 2).

The idea presented was that by showcasing 10,000 workers in collective labour effort, that this would prove the efficiency of communist labour practices. Nuclear energy also had the capacity to improve the relative status of specific Soviet republics in relation to others in the eyes of the USSR Central authorities. For instance, in relation to the Czech Republic, one participant in the Munich workshop noted:

> "There was demand for nuclear due to a political influence, a hunger for the new knowledge, for the new power. It was a very political decision. (Munich group 2)

From the Atoms For Peace rhetoric onwards, civilian nuclear power, and notably the quest for fusion power, are very clear examples of *socio-technical imaginaries* (Jasanoff and Kim 2009) constructed around *technological optimism* - dominant collective social identities at the highest levels of government, through which technological development, progress, and knowledge about nuclear become powerful drivers of policy. At the collapse of the Soviet Union, the rhetoric of atoms for peace was perceived to re-emerge - the peaceful applications of nuclear energy were a sign of both international standing and of technological modernisation. For Germany, for example, this was described as:

> "[For Germany] Atoms for Peace was "welcome back to the family", nuclear power meant acceptance." (Munich group 2)

Nuclear energy is thus presented in terms of globalism – engagement across previously isolated Cold War powers. Trust to trade with the reunified Germany, and to encourage regionally connected nuclear energy, was thus seen as an international test of this globalist engagement. It is notable that the sociotechnical imaginary of nuclear is to broad extent perceived as more important than the more mundane economic forecasting of energy prices in shaping decisions. Indeed, it is clear from the workshop discussions that's the way in which nuclear energy is imagined by key policy actors is very powerful in changing the energy landscapes of the respective countries. What is clear however is that different countries have very different political attitudes towards involving civil society actors - including members of the public - in shaping the sociotechnical imaginary of nuclear-power. And this in turn is partly dependent on the Democratic status of the nation in question.

A role for public engagement

At the heart of the HoNESt project is concern with civil society engagement with nuclear energy. This type of engagement has many facets and forms. In authoritarian regimes, such as those of the USSR, participants commonly talked about governments acting unilaterally (in some cases this was perceived to be without civil society consent) to develop the technology. Scientists and engineers became allied to these nuclear projects, and ultimately had very little sway over their development, siting, or construction. Under authoritarian regimes the socio-political structural conditions are perceived as fixed and immutable – politics is almost universally defined in terms of institutional

constraints (in essence as a "closed society", see Popper 2012), and there was very limited direct agency of citizens and other stakeholders to affect change, until those regimes fell (with the fall of the USSR, or the death or removal of fascist leaders in Spain and Portugal respectively). When asked directly by the facilitator in one of the Barcelona groups about a role for public actors under authoritarian regimes, the response was that even though there were opportunities for public meetings and other forms of group decision-making activity, in the context of the USSR and Warsaw pact countries (and specifically in Bulgaria):

Speaker 1:

> "It is communism, if you have money you can buy these things [reactor technologies]. We have news, but they are fake, they are not informed. You have public meetings, but real public expression is not that. In communism, it is a puppet society, there is a show and a real discussion happening elsewhere."

Speaker 2:

> "In Russian history, they call it kitchen conversation" (both from Barcelona group 2).

A common feature in the construction of the milestones across the River of Life were individuals who were identified because they circumvented or augmented the power of authoritarian regimes in the Soviet Union, or under fascist control, by appealing to other authorities (the church, foreign powers, scientific institutions), or by defecting and then engaging in technology transfer activities from a position of safety in the West. The *agency* of individuals to shape the social structural/institutional landscape of authoritarian regimes appeared to only occur when agents (notably scientists) could co-opt the power of other external authorities to counter the power of domestic fascist or communist governments. When it comes to the discussion of the actions of individual scientists in authoritarian regimes, there are a few noteworthy examples. For instance, discussion of early nuclear development in Bulgaria was framed in terms of a "Mother and Father of nuclear technology" (Barcelona Group 1). Elisabeth Ivanova Kara-Michailova (the referenced mother of nuclear power) was a nuclear physicist and pioneer of women in science, but her involvement was framed in terms of an individual whose career struggled because she was anti-communist. In the Barcelon group 2, there was much discussion of Fermi, and in the London workshop or Oppenheimer and Einstein. What is notable is that when it comes to the description of different scientists, this is primarily in terms of their competencies, their political stance, and the relationship to the prevailing political or ideological conditions in which they operated. This is an important finding in terms of engagement – that the power to create structural

change is, in authoritarian regimes, perceived as an external rather than internal process. Individual citizens are commonly construed as powerless to enact change. Thus although public meetings and other forms of communicative exercises led by communist authorities were mentioned, these were generally agreed to be a form of *placation* rather than *engagement* in any meaningful sense (see for example Arnstein 1969), in a manner described in D4.3 of the HoNESt project (Espluga et al. 2018).

When looking at comparator democratic regime responses to scientific and technical engagement, unsurprisingly, in the context of American and West European nuclear development, many of the key agents mentioned in early nuclear energy programmes were scientists and engineers of the Manhattan Project. These actors featured heavily in structuring understanding of and engagement with the science of nuclear energy in the late 1930s and 1940s. In the River of Life sessions this period was commonly represented a bomb with a radiation symbol, or the iconic mushroom cloud. During this period, it was the actions of scientists from the Manhattan project itself (Oppenheimer and Bethe featured heavily and Einstein, Fermi and Feynman were all mentioned).

Though discussions in relation to the authoritarian regimes primarily prefaced with discussion of the bravery and tenacity of scientific actors in the face of strict ideological political constraints, there is a corollary to that in the west. For example, one participant in the London workshops made reference to the French nuclear programme and highlighted how scientists (notably Fuchs) came to Chalk River for research purposes, but were arrested and detained and:

> "…given the label spies. The whole situation would be different because two key actors had different political views from the perspective of America, and it would have been very different if they had been Christian democrats, for example." (London group 2).

Under the Cold War conditions, military nuclear secrets and anti-communist political ideology are perceived to *close down* (Stirling 2004) engagement on nuclear policy in the West. But there is an interesting similarity between the actions towards anti-communist sentiment within the Soviet republics and pro-communist sentiment within the United States. Both can be understood as the constraining structural conditions under which nuclear science operated. Given the importance to individual actors that the participants highlighted, it seems that there is a common frame through which participants presented their respective nuclear "stories". We could call this trope - a storytelling device, namely the heroic struggle of an individual in the face of adverse external forces. This idea of the heroic scientist has considerable impact upon the perceptions of engagement processes that surrounded nuclear energy development across the USA/Western European and Eastern European

powers. It is clear that the actions of individual scientists, rather than external stakeholder groups or heterogeneous publics were perceived to have had the greatest influence upon policy development both within Western democratic nations and amongst the authoritarian regimes of fascist Spain, Portugal and the communist countries of the USSR at the birth of the nuclear industry.

Democratic political regimes and engagement with science and technology

Though in many of the authoritarian political regimes science was presented *heroically* – as individual scientists striving to overcome the constraints of an oppressive political environment, in the context of the democratic nations (specifically UK, France, Belgium and Sweden) scientific engagement with nuclear energy and society was portrayed in more ways than this. The role of scientists was framed less in terms of the actions of individuals to overcome systemic constraints, but rather in terms of the collective action of scientific, independent, quasi-autonomous non-governmental, or governmental advisory bodies, to affect change through collective action and active involvement in policy networks. The mechanism through which these agents had control over the social structural settings of nuclear energy was perceived to be primarily through *scientific reporting* and *independent advice*, and this is discussed in detail below.

Unsurprisingly, given the origins of the first civilian nuclear programmes in both uranium enrichment and plutonium production (in the UK for example this was explicitly discussed as a core aspect of the weapons programme), The Manhattan Project, and its later counterparts in Europe, played a strong role in shaping the participants' understanding of 'where nuclear energy came from' (so to speak). It is notable that the Manhattan project, despite its devastating consequences in Hiroshima and Nagasaki, was mostly portrayed with either positive or neutral sentiment by participants. As one London participant put it:

> "The context of the war was very important. Oppenheimer was trying to defeat the Nazis, he was in a battle of good against evil. And to do this terrible thing to prevent this catastrophic thing to prevent a terrible outcome, the loss of The Allies. The shift from, the scientific to the political is very important." (London Group 1).

Oppenheimer and Einstein were mentioned as important figures framed in the *heroic scientist* trope - having gone from developing nuclear weapons to recanting and then campaigning against nuclear weapon proliferation. The

relationship between military and civilian uses of nuclear technology following on from Manhattan Project was primarily framed in terms of funding, technology transfer, and regulatory governance. There was considerable discussion around how the Manhattan Project "turned on the funding tap" (Barcelona group 1) for nuclear projects across the west. In the Barcelona workshop group 1, this was drawn as a giant bucket pouring money into the river. Though there was general agreement that nuclear weapons "came first" in terms of technology development programs in the west, not all agreed. One participant in London group 1 workshop wanted to reframe the portrayal of the history of radiation science and the promise that those discoveries held:

> "Can I go back even further to 1890 to when they discovered radiation, Marie Curie. I wouldn't like the beginning to be linked necessarily to weapons production" (London Group 1).

It is important to note that there was considerable debate about where to start the narrative of nuclear energy, particularly in the London workshops. When discussing Western engagement with nuclear-power, the early scientific discoveries from physicists such as Marie Curie were perceived to have had significant repercussions for engagement practices throughout the 20th century. Workshop participants in London, and in Munich, highlighted how radiation was first seen as something positive for health and to future technological development. For example, the radium springs were mentioned – that radioactive waters were treated "as an elixir" (London Group 1) in the early days of radiation science. Thus, early public reactions in the late 19th and early 20th centuries were initially positive – participants noted that there was an almost *alchemical* approach to understanding radiation – it was presented as a solution to many problems, and promoted as a quack cure for a range of different ailments. As an engagement issue, this set of positive associations that emerged in response to early radiation science communication had a powerful and long-lasting effect. As one participant put it:

> "The early promise and the awe that radiation created also led to the flip side – the fear that happened later. So, with great power comes great responsibility" (London Group 1).

The very earliest engagement processes in the nuclear field were perceived to be around radiation safety. The first public communication activities were construed as those trying to dispel the myths that consuming large quantities of radioactive elements would be good for health (for discussion of this point see Macklis 1999). Of greater significance was the practice of science communication around radiation protection that emerged after the Japanese bombings and nuclear weapon testing programmes in the 1950s and 60s. As one participant noted:

> "Marie Curies' cancer led to radiation protection, and Hiroshima and Nagasaki, the American army were interested in finding out if soldiers could enter irradiated environments" (London Group 1).

Engagement with nuclear in the immediate post-War period, was primarily discussed in terms of radiation protection science. One participant noted that radiation protection was initially of interest to military authorities trying to protect soldiers, and to model the consequences of strategic nuclear weapon use and how this would potentially interact with military personnel under different Cold War scenarios. The exposure of military personnel to harmful radiation was described as an institutional mistake. Yet as other participants discussed, such mistakes allowed collective learning about future nuclear safety which informed industrial development in the 1960s onwards. By learning about the consequences of radiation in war, this helped to standardize the Linear and No Threshold Hypothesis (LNTH) of radiation protection, which in turn led to more stringent safety standards for civilian nuclear energy. Numerous participants at different points highlighted how the nuclear industry is one of (if not the) safest in the world in terms of its Record of industrial accidents, in terms of public exposures to hazardous radioactive materials, and in terms of the strength of International regulation (through the IAEA, Euratom, and the NEA), and down to domestic regulatory bodies. There is, therefore, an emergent representation of nuclear safety as *comprehensive* or *thorough*, and the institutionalization of radiation protection standards is grounded in the results of these widespread exposures during the bombings in Japan, and weapons testing in United States.

Though there was a positive understanding of radiation protection science amongst participants - which is also a contentious issue of public engagement. It is notable that both of these examples have clear military origins. As such, the findings about radiation safety were deemed by some to have been kept secret for too long. Some argued that findings about radiation effects upon biological organisms where not immediately shared in the public domain, and this strategy was used as a means to deflect public attention towards civilian nuclear energy programmes at the time. As found in a number of nuclear history studies (not least those of the HoNESt project) (Wynne 1982, Hall 1986, Weart 1988) the power of military secrecy to 'close down' (Stirling 2004) civil society engagement with radiation protection, defense programs, civil nuclear electricity, uranium mining, enrichment and spent fuel reprocessing both during and immediately after the Cold War, is significant: these issues were thoroughly discussed in the workshops, primarily by stakeholders who identify themselves as being in opposition to nuclear energy. This issue of opening up and closing down discussions about the social desirability of nuclear energy is discussed in more detail below. However, there are a couple of final points on radiation protection science and its relationship to engagement that are relevant. The first is that radiation protection within this military nuclear field was argued to have become first politicized in the United States during the Vietnam War:

> "What happened in the US? The Atom is great it makes us (the USA) a superpower, and at the same time the opposition until 1975, during the Vietnam war, they were against the use of bombs, and scientists among them (the radiation protection scientists) are campaigning against this, so nuclear becomes 'bad'." (London group 2).

It is noteworthy that the military origins of radiation protection science are discussed as being the origins of negative public perceptions of nuclear risk. One of the interesting engagement-related findings relates to the dichotomy that emerged between pro-nuclear technological optimism amongst the civilian programmes, and the government boosterism that supported civilian uses of technology as a consequence of Atoms For Peace; and the increasing role of radiation protection scientists to shape political discourse around nuclear safety. It is notable that participants recognized the polarizing nature of this debate. They commonly discssed radiation protection science has tended to push civil society actors into "for-or-against positions" with regards to nuclear energy. Consequently, this raised concerns amongst democratic decision-making authorities that anti-nuclear bomb protest organisations (for example in the UK the campaign to nuclear disarmament CND was mentioned prominently) might in turn become threats to civilian nuclear programmes. It was mentioned, particularly in London and Munich, that Government concerns over peace movements to stir public sentiment against civilian nuclear power became the primary motivating factors to shield the industry and public scrutiny. Yet this action was deemed unsuccessful. Participants commonly discussed the relationship between nuclear weapons and civilian nuclear energy in shaping public attitudes to nuclear technologies in the round, and in turn, creating the political-institutional configurations that favoured certain attitudes to stakeholder engagement within governmental authorities. In essence, military secrecy failed to contain antinuclear sentiment in civil society. The reason for this was largely because of the impact of nuclear accidents, the rise of televised media, and a broader concern internationally over the management of environmental risks to health and ecological stability. Nuclear accidents were universally used as key milestones in the visualization of the River of Life.

Nuclear accidents and civil society engagement

The first significant nuclear accident that was discussed was the Windscale Pile fire in the United Kingdom. As one participant said in relation to the fire:

> "The Government covered the Windscale report up, as it was a military experiment and the UK Government didn't want Russia to know what they were up to…. They were aware that allowing this understanding into the public domain would stimulate public opposition and an anti-nuclear

> movement in the late 1950s and 1960s. The growing power of CND (against bombs) there was concern that the public would stimulate the power of this organization against nuclear". (London group 2).

The Windscale fire was construed as a critical turning point for nuclear politics in the United Kingdom. There was perceived concern amongst the participants that the impact of Windscale was lessened because, firstly, it was covered up under military secrecy conditions, secondly, because it was geographically and politically remote from major population centres, and thirdly, because Parliament was not fully aware of the facts surrounding the case. The other two most significant nuclear accidents were Three Mile Island and Chernobyl (it is notable that Fukushima-Daichii received comparatively less attention, though this is likely due to timing constraints of the workshop – moving chronologically from past to present). The impact of both were discussed in great detail. Across all of the workshops these incidents were marked as key milestones in the River of life for the respective nuclear energy-producing nations. However, the impact of these events was not universal across Europe. For example, when discussing the United Kingdom one participant in the London workshops stated:

> "Three Mile Island had a small political reaction in the UK, because the Government had just lost a general election…. It had a big effect in Germany but virtually no effect in the UK" (London group 2).

In other cases, the combination of Three Mile Island (TMI) in 1979 and the film China Syndrome in the same year were discussed in engagement terms. There was a sense that the combination of fictionalised nuclear catastrophe and a real nuclear accident became conflated in the public imagination, such that the nuclear fear grew in the United States, and this spread through international news media to Western Europe. As discussed in the Munich workshops, the influence of Three Mile Island on environmental protest and the rise of green politics was deemed to be significant and long-lasting. It was mentioned in a number of cases, that TMI had a significant impact upon tightening safety restrictions, regulatory frameworks and oversight of nuclear operations in western Europe and in the United States. Collectively, this provided a great opportunity for civil society engagement, because of the rise of televised media, international reporting, and a growing concern around environmental issues at this time.

This was deemed instrumental in the rise of public fears about nuclear safety, which in turn influenced the types of uninvited engagement that occurred. The role of media reporting extends beyond just accidents however. In the UK, this is discussed primarily in relation to the thermal oxide reprocessing facility (THORP). One of the participants in the London workshop mentioned the role that a single headline played in shaping engagement:

> There was a headline in 1975: "Britain to become nuclear dustbin of the world?" In the Daily Mirror. (London group 2).

It was discussed how the media storyline around spent fuel reprocessing and waste management stimulated public concern for the actions of the nuclear industry, and there were similar examples raised in the Munich workshops around the proposal for a salt dome for radioactive waste in Gorleben. One of the aspects that could be clearly identified is that the most negative reactions to nuclear risks were perceived to emerge not from the siting of power stations, but rather from waste facilities and reprocessing facilities. Strong public reactions were amplified by the media reporting: these issues appear to arrive "suddenly" in public discourse. By this we mean that radioactive waste management had not been a major public concern up to the early 1970s, but the increased reporting of waste-related issues happened in a relatively short period of time.

As some of the participants discussed in the London and Barcelona workshops in particular, media reporting of both major international nuclear incidents and routine planning applications for waste and reprocessing facilities, created grassroots political pressure to open nuclear industry decisions to wider political scrutiny. Then, when the Chernobyl incident occurred in 1986, this was argued to compound antinuclear sentiment within civil society, emboldening antinuclear activist organisations and leading to political pressure within many democratic regimes to phase out or delay nuclear decision-making. However, the effects were not just felt in the United Kingdom, France and Germany: as one participant in the Barcelona workshop discussed about Italy:

> [In Italy] "everything stops around Chernobyl… even the plans, everything turns to gas" (Barcelona group 2)

Italy voted soon after the Chernobyl incident in a referendum to stop nuclear energy, though this was an outlier in terms of political reactions to nuclear energy in Europe. In Bulgaria, for example, the nuclear incidents of TMI and Chernobyl were deemed much less important in terms of nuclear energy decision-making than other geological risks:

> "In 1977 there was a major earthquake in Romania, the soil moved by 1 meter the reactors survived without any damage… the experts were concerned, so they went to Japan and used Japanese technology, with shock absorbers. This caused delay, and the third and fourth [reactors] were put in 1982 and 1984." (Barcelona group 2)

It seems that within the USSR, participants argued that TMI was seen as a problem of the West, and therefore not really applicable to Bulgaria, and so

policy learning was perceived to occur 'closer to home' as shown in the quote about Romania above.

In the democratic regimes of Western Europe, despite the growing power of Green politics in Germany and Sweden, the impact of nuclear accidents upon nuclear policy-making was also deemed be relatively small. It was interesting that when the Chernobyl incident was raised, it seemed that participants were careful not to overstate its impact on nuclear energy policy-making. The power of television in stimulating adverse public reactions to nuclear risk was discussed quite thoroughly. We can understand participants' reactions to the role of international news media in stimulating risk perception as implicitly drawing upon something akin to the social amplification of risk framework (SARF). SARF is based upon the principle that some risks become "amplified" as messages about them are emphasised within news media, addressed by public officials, that stimulate scientific (and often quasi-scientific) debates in public forums (including in the 21st-century on social media) (Kasperson et al. 1988, Pidgeon, Kasperson, and Slovic 2003, Petts et al. 2001). Other risks however become attenuated or suppressed. What was interesting about Chernobyl as it was discussed in the workshops, is that although it was recognised that the fire and resultant radioactive fallout across Europe had a significant immediate effect on public perceptions of nuclear risk, this effect was (generally) not deemed to be long-lasting. To summarise, although it was often stated that in the 1980s the Chernobyl incident was significant in influencing nuclear policy-making, other factors such as the liberalisation of energy markets and the "dash for gas" were deemed to have had a greater influence upon the quantity and supply of nuclear reactors to energy markets (or the lack thereof) in the late 1980s and early 1990s (specifically in the United Kingdom, Sweden and Germany). For example, one London workshop participant stated:

> "Thatcher wanted to build new nuclear, but also wanted to privatize everything and those two are incompatible… Market economics. Nuclear only works in the 1980s if the government took on board the liabilities. "(London group 2).

Thus, although in one sense the globally televised shock of Chernobyl had a powerful impact on civil society engagement with nuclear energy, participants recognised that ultimately this had relatively little effect on the energy landscape of the United Kingdom, France, Sweden and Germany in the subsequent decade.

Independent scientific advice

Though participants tended to recognise that economic factors had a strong influence in the types of energy sources that were built in the 1970s, 80s, and 90s (namely the influence of the oil crisis, conflicts between governments and

coalminers' unions, and then later the ending of the Cold War), when it comes to looking at non-economic factors that influenced engagement with nuclear energy one of the most significant issues is that of independent scientific advice. Specifically, participants questioned the role that independent scientific advice plays in shaping government policy, and the availability and the types of scientific information brought to bear in decision-making.

It is worth noting that independent scientific advice is perceived as a mainstay of regulatory processes and approval mechanisms within the nuclear industry. However, that scientists have direct involvement in nuclear matters is something that is debated from different standpoints. Under Cold War conditions, participants in workshops discussing the UK's military programme, and that of France and Spain, mention that at times the nuclear industry was 'technocratic' or even 'technophilic' (London group 1) in the sense of following the advice of independent scientific experts in shaping policy, and at others, scientists were excluded for political-ideological reasons. For example, one participant in the Barcelona workshop (Barcelona Group 1) mentioned The French 'Messmer Plan' published after the Oil crisis hit in the early 1970s. This is described as a top-down implementation of a nuclear policy without scientific support at the time. (The Association of Scientists for Information on Nuclear Energy was formed in response to concerns about the lack of scientific scrutiny of the plan (Nelkin and Pollak 1980) The common understanding of nuclear engagement is that in the 1960s, 70s and 80s decisions were technocratic – that is, they were led by scientific and technical expertise. But as discussed elsewhere in this report, participants often argued that broader political and ideological factors served, at some points in history, to crowd-out scientific expertise, to diminish dissenting voices, or to withhold key information from decision-makers, effectively engaging in forms of *closure* (Stirling 2006) around nuclear energy technology assessment.

One of the key forms of 'closure' was identified in the milestones expressed in the River of life method. During discussion related to France, the United Kingdom, and when referring to the reunified Germany (in particular), *scientific reports* were commonly reported as 'milestones'. For example in the UK the Maud report, Smythe report, and Flowers report were mentioned in succession (the *Maud report* that emphasized the use of nuclear energy for heat generation, t*he Smythe Report written by Henry DeWolf Smyth that detailed the development of the Manhattan project and the Allied effort to develop atomic bombs, and the Flowers Report* that highlighted the need for a long-term radioactive waste management strategy before continued expansion of the nuclear industry could be countenanced in the 1970s). This is significant, because continuous technical change in the nuclear industry (as in any innovation sector) required the development in close proximity of publicly funded basic and applied research (Pavitt 1998) and the development of

regulatory instruments associated with scientific and technical oversight of operation. The reports produced by independent scientific oversight bodies are crucial to the development of such regulatory instruments.

We can interpret scientific reporting - as represented in the workshop discussions - as a process that *punctuates* the continuous evolution of nuclear energy policy in democratic nations. What is relevant about this theory as it relates to the workshop discussions is that when scientific reports are mentioned, they are very often construed as socio-political artefacts that punctuate a continuous trend of sectoral innovation within the nuclear industry. To give an example: The Flowers report was discussed in the London workshops. The report was the first time in which a leading physicist had questioned the continued expansion of nuclear energy programmes in the UK, based on concerns around (notably) the future generational impacts of long-lived radioactive wastes. The report was perceived as highly influential in restructuring the UK government approach, firstly to radioactive waste management (which had been largely ignored up to this point because the Magnox and early AGR programmes appeared to be going so well), undertaking site safety and anti-nuclear proliferation issues very seriously. Secondly, the report was influential in getting the UK governments to set up the nuclear industry radioactive waste executive (Nirex - a decade later). We can describe the report as stimulating a period of punctuated equilibrium in the industry, because it didn't halt or accelerate nuclear energy production - there was no call for a moratorium or ban within government, although the report was nevertheless instrumental in altering the character of the policy landscape and the regulatory structures of the industry during a very short period of time, which had lasting-effects upon the trajectory of the industry. The extent to which specific reports change the policy direction of the nuclear industry in different regional contexts is certainly worthy of further exploration.

Some scientific reports had very public recommendations. Advisory reports such as the Flowers report (in the UK) had a powerful influence upon the scientific and regulatory frameworks for nuclear energy (as discussed in the London workshop group 2). Yet of great significance were those scientific recommendations that were not public. In the Barcelona workshops with regards to nuclear energy development in southern Europe, and in the former Soviet/Warsaw pact socialist republics, and in London regarding the UK, there was considerable discussion about the overlapping nature of military regulation of nuclear sites, and the secrecy that closed down opportunities for broader civil society engagement with nuclear policy. In non-democratic country contexts, this secrecy was largely attributed to the authoritarian nature of the regime and the lack of transparency in governance practices. Yet this was also deemed to be true in democratic nations with regards to nuclear energy development; as participants in London group 2 discuss:

> "Public engagement, you've said top secret, but the other crucial thing is that the UKAEA the only civil servant was responsible to the Prime Minister only, and not to Parliament, until 1973". (London group 2).
>
> "It was based on "Propaganda, but not facts" (London group 2)
>
> "Magnox was a non-commercial programme for military purposes presented to the public as being for commercial purposes." (London group 2)

There is a strong narrative discussion around not just secrecy, but *dishonesty*. This was clearly discussed in relation to the British nuclear project, though similar counterparts were discussed in relation to the French and German nuclear programmes. A narrative is presented that combines the boosterist attitude of governments towards nuclear in the 1960s, the technological optimism that surrounded high-tech energy developments amongst broader publics, and the secrecy that surrounded the risks. What is interesting to note, however, is that even when such sentiments are expressed, the actual role of scientific advisory bodies remains largely uncontested. In other words, blame is, for the most part, not directly attributed to scientists, nuclear engineers, military officials or specific politicians. This can be understood as reflecting a broader trend in social discourse about the relationship between science and policy making. As Jasanoff (1990) notes, scientific advisory bodies have a curiously sheltered position within policy and regulatory systems. Advisory bodies are generally perceived as an indispensable aid to policy-making across the nuclear sector (and innovation sectors more generally). They are politically desirable because they are low-cost, provide competence, independence, and are relatively resistant to political lobbying. There were many scientific advisory bodies mentioned in different national contexts - these also appeared at key milestones within the nuclear sector development of different countries, and are too numerous to list here. However, various broader trends can be discerned. The first scientific advisors were identified primarily as physicists that helped to develop industrial technology for reactors of both civilian and military intent. As mentioned previously, promoters of the Manhattan Project, and subsequent domestic weapons programmes, were commonly discussed. It is important to note that in general, participants did not attribute negative sentiment to the activities of these scientists.

The lack of *blame* is significant because of changes in cultural norms and practices that have emerged within modern European science governance. Notable among these is the concept of responsible research and innovation (RRI). Increasingly, we question not just the quality of science, but the intentions of the scientists themselves, the impacts of scientific discoveries and technological developments, and the role that science plays in shaping policy-making and broader cultural trends. RRI counters the natural inclination of

existing scientific advisory systems to fall back on the style and culture of positivistic science when a problem appears complex, or when lobbying for a particular course of action that supports a particular interest is strong and influential (Frewer and Salter 2002, Taebi et al. 2014, Owen, Macnaghten, and Stilgoe 2012), to think through the economic, social, environmental and political consequences (how the positives can be amplified and the negatives attenuated). In short, sound science is no longer considered as sufficient normative justification in itself for scientific action. It is notable, therefore, that even when participants expressed legitimate anti-nuclear sentiments within the workshops, they tended to frame the position of scientists in the development of early nuclear weapons and civilian nuclear energy programmes in a positive (or at least relatively neutral) light. From analysis of the workshop data there is a clear sentiment (though we would be careful not to state this as universally accepted) that scientists "at the time" were motivated by a normative position to produce nuclear energy for the good of society. Expressions like "golden age of nuclear" or "nuclear utopia" we used to describe this early nuclear development phase, when there was evidence of Government boosterism of nuclear energy programs, relatively positive civil society perceptions, and optimism about the future technology. Participants were empathised with the physicists and pioneers of early nuclear programmes in acting in the public interest, even if with hindsight those participants believed that nuclear-energy was not in the public interest for environmental or other reasons.

What was also clear, however, is that participants reported a strong reliance upon the input of scientific advisory bodies in policy-making, both within democratic and non-democratic countries. The development of nuclear energy in the 1940s, 50s, 60s, 70s and 80s is commonly understood as a technocratic era where scientific advisory bodies had considerable sway over public policy directions (Bella, Mosher, and Calvo 1988, Malone 1991, Blowers and Sundqvist 2010, Augustine 2018). This was significant because, as one London workshop participant expressed:

> "There was a proliferation of advisory bodies and committees [in the 1960s and 70s]" (London group 2).

The proliferation of scientific advice, and technical authority is discussed thoroughly in or all of the workshops. In relation to France and Germany this was interpreted conceptually as, what could be termed, State Engineering (see for discussion Hecht 2009 for example, Trischler and Weinberger 2005) i.e. there was considerable national pride in technological achievement that elevated the status of engineers within society. As one Munich workshop participant noted:

> "The technology is still among the best in the world and these are exemplary points of German engineering." (Munich group 1).

The idea that technical systems and the engineers that built them are of particular quality and reliability is deeply important from an engagement perspective. Firstly, as mentioned, because state engineering is a source of cultural, even national pride. In the Munich workshops, there were repeated utterances that German engineers could be trusted, and therefore domestic reactor designs could be trusted to be safe. However, from a civil society engagement perspective participants had a more nuanced view about how this trust in technical authorities did not extend to political institutions that made technical decisions. In short, as engineering became politicised, public trust in the nuclear industry declined. Trust in institutions, in technical authorities, and in nuclear technologies, were not the same thing. For example, though engineers and their systems occupy a position of trust within German society, there is concern that this creates an aloof class that fails to engage appropriately with concerned public actors, to the point that the German public did not trust that they were being told the truth about the risks of nuclear Energy, and most significantly, about long-term radioactive waste disposal. This is a demonstration of the downside to technocratic decision-making processes. As the Munich participants noted:

First speaker

> The language used by experts in the nuclear industry is one of the biggest issues of public trust…. How can we shift this burden into the field of trust? … Who is paying for trust in the nuclear industry. (Munich group 1).”

Second speaker:

> “What we require is a common approach in language around nuclear in order to build this trust.” (Munich group 1).

In the German case, as one participant in group 2 of the Munich workshop noted:

First speaker:

> “The fourth nuclear programme was the basis for the nuclear energy getting into the Republic. As the oil crisis came over Germany, the energy programme planned to have around 30 reactors in Germany, and that was a signal for public acceptance to question public safety …

Second speaker:

> “[the problem is that the government was] Ignoring public safety, the first reactors were the boiling water reactors and there was never a report on safety”

Third speaker:

> "[supporting speaker 2] For example, the nuclear waste disposal centre – a reprocessing plant combined with a storage plant for HLW. It was one of the main arguments of the public "well you haven't solved the disposal problem, so how can we trust you?"

These examples illustrate how there is a complex discourse of both pride and mistrust presented in the social representation of nuclear expertise, and this is most strongly expressed in the German case, though there were similar expressions when discussing France and United Kingdom. Nuclear energy was recognised as a means to achieve global recognition at a point of German reunification, and so trust in engineering was strong within the state. What is important to note is that scientists and engineers had (and to some extent to continue to have) elevated social status within civil society (this was believed to be true in both Germany and France). The actions of nuclear engineers in this period are imagined by workshop participants as a public good and something akin to a *public technology* (Bud and Trischler forthcoming) (this sentiment reflects the sentiments of majority opinion within the Munich and Barcelona workshops). In essence, there were points in history where technocracy *worked* because there was considerable trust in technical authorities, and points where the politicisation of nuclear energy meant not only a declining trust in politicians to make technical decisions, but also a crisis of trust in engineers. Thus, when contemporary critiques of technocratic nuclear decision-making are proffered by workshop participants, this is often couched as "wisdom from hindsight" in most cases: some lamented the lack of trust in the technical capabilities of highly educated and honest individuals, others pointed to the hubris of technical authorities to present nuclear energy as safe whilst simultaneously hiding information about system safety from civil society organisations. As one London participant put it:

> "There were small elites within Government. The scientists were genuine, but the people who supported it [nuclear energy in the 1960 and 70s] were disingenuous." (London group 2).

Though it would be fair to say that the technocratic era was characterised as one where there was little public opposition to nuclear energy, this was not universally true across the cases. In Germany and in the United Kingdom, participants discussed how a lack of publicly reported safety reporting, and failures on waste management communication strategy (in Germany), and failures of public engagement around radiation protection following Chernobyl and in response to the thermal oxide reprocessing plant (THORP) (in the United Kingdom), led to growing public mistrust and the rise of antinuclear sentiment in the late 1980s and early 1990s. Germany is an important critical case for understanding nuclear engagement, and how relative positions of trust in technical authorities *still* lead to active anti-nuclear public sentiment, leading to

policy failures (Whyl is a commonly mentioned example – where the rise of anti-nuclear activism amongst wine growers and farmers led to *non-decision making* on nuclear issues – pushing decisions on site selection back until they were eventually abandoned). Similar sentiments were expressed in the London workshops about the U.K.'s nuclear programmes, and in relation to Portugal and France.

What is significant is the capacity of local actors to influence site-specific decisions over nuclear energy facilities. The Whyl example was discussed heavily in the workshops in Munich and serves as a critical case in describing how collective action forces policy change when engagement with local people is deemed to be insufficient. To the participants, the case represented a powerful example of how locally organised civil activism shapes the nuclear energy policy landscape both locally (in the sense of delaying the decision over a specific power station site), and in national terms (by stimulating collective protest actions against nuclear energy across Germany, and by bolstering green environmental political movements more broadly). Whyl is an example of how perceived democratic deficits at the local level of politics are addressed through bottom-up engagement practice. This is commonly referred to as "uninvited" engagement, in the sense that collective action has the capacity to force other forms of engagement practice within the industry and within government that would not have otherwise occurred (see for example Wehling 2012).

Such responses were common throughout the workshops. The influence of engagement in advancing or halting nuclear energy development was described using a number different metaphorical constructions. For example, the radioactive waste management issue in Spain was described as:

> "…the hand of politics blocking radioactive waste site selection" (Barcelona group 1)

Or in relation to Greece, it was described as:

"We are like a dam, without an exit" (Barcelona, group 2).

Social movements of opposition were not universally described in positive terms. Opposition movements were variably described. Some participants construed them as campaigners for environmental justice that countered the power of industry lobbyists in civil society. Others viewed them, alternatively, as NIMBYs, or as antinuclear environmentalists who would not embrace the environmental benefits of nuclear power despite the evidence to support its value in meeting sustainable development goals. Whether or not the

participants believed that the blocking of nuclear sites was desirable, depended entirely upon the ideological positions and commitments of those individual stakeholders. There was no consensus on the value of opposition and protest in shaping nuclear policy landscapes. There was, however, agreement that when engagement processes from centralised governmental and industry authorities were deemed to be lacking by locally affected public actors, then protest movements would arise to fill the perceived democratic deficit. Thus, the extent to which governments act on 'getting the engagement right' (London group 1) becomes an important indicator of the overall level of civil society support for nuclear energy.

We see similar activities discussed in relation to Sweden and in France, though it was clearly articulated in the London workshops in relation to the U.K.'s nuclear energy programme. What was interesting about the UK was that engagement practice was primarily construed as being within the planning system. When civilian nuclear energy sites were proposed a perceived lack of local engagement was expressed:

> "Engagement with local publics, around Sellafield or Hinkley, there was absolutely zero" (London group 2).

Processes of planning inquiry were deemed to be the primary mechanism through which local people had an opportunity to challenge the need case for new nuclear energy infrastructure, to articulate environmental protest concerns, to raise issues of radiation safety, or to mobilise counter-scientific expertise in a public forum. The engagement practices of the industry throughout the latter half of the 20th century were described in terms that Hindmarsh and Matthews (2008) would describe as "deliberative speak" - i.e. there was a growing language around consultation and engagement, but this was not backed up with mechanisms to provide local actors with an opportunity to challenge nuclear energy site proposals. As one participant described it, local people when consulted only had the opportunity to make decisions over:

> "the colour of the fence, or the number of lorries" (London group 2).

The public inquiry process was important in the UK context – because planning (and the failures of planning processes that stimulated enquiries into THORP and Sizewell power stations for example) were perceived as the primary mechanism through which engagements took place.

The only country that appeared to be perceived as a leader in local community engagement was Sweden. Though there was relatively little Swedish representation within the workshops, where Sweden was discussed it was identified really as an exemplar of engagement practice that draws in local

community support from the start, as an upstream process rather than a downstream process. Upstream refers to engagement practice at the point before a decision on site selection has been reached. Sweden was alone in using this kind of upstream dialogue process; in all other cases engagement was discussed primarily in downstream terms - decisions on the type of technology to be deployed, and where it should be sited, were made by either national or regional decision-making authorities. The scale of the decision was taken at the national or regional level, and so local concerns (and by extension those of local people) were largely perceived to have been shut out of decision-making.

There is a *scalar justice* (Bickerstaff and Agyeman 2009, Jessup 2014) argument inherent in many of the discussions around engagement of the local level. By scaling decisions over nuclear energy site selection at the national level (as a public technology for the public good, see: Bud and Trischler forthcoming) this creates specific forms of engagement - namely those around consultation, information provision or placation (Johnstone 2014, Cotton 2018). However, where local actors perceive a lack of opportunity to engage with policy decisions, they will form collective action through social movements of opposition in order to force decision-makers to adopt their demands (reshaping structure through strategic learning and coordinated action, see: Jessop 2007, Hay 1995, Jessop 2001). We can understand this again in terms of the opening up and closing down of dialogue on nuclear energy technology options. Where policy-making processes curtail opportunities for local people to have input in decisions, this in turn stimulates protest actions, unites local actors, and then forces policymakers to open up technology appraisal processes to a wider range of voices. We can see therefore that engagement is a dialectical process of structure and agency - when local actors lack the power to make decisions, they politically strategize to change the functional systems through which decisions are made.

Conclusions

We can understand engagement practice within the nuclear energy sector as having multiple dimensions at different scales of governance. Within the workshop discussions there are clear demarcation lines between the governance practices of the democratic nations of western and northern Europe, and the authoritarian regimes of former fascist and Soviet republics, the differences primarily lying in the capacity of individual actors to influence the policy landscape. In democratic nations and in authoritarian nations, the early nuclear industry was highly influenced by the actions of “heroic” scientists (usually physicists) who pioneered the development of both military and civilian nuclear technologies. The earliest engagement forms under both of these regimes were technocratic in the sense that scientists had considerable political

power in shaping technology choice. However, nuclear energy was stimulated by a range of structural factors which influenced both democratic and authoritarian regimes. The economics of post-war reconstruction required political investment in alternative fuels in order to stimulate industrial growth and development. Civilian nuclear energy carried with it considerable soft power, showing the technological capabilities of the nation state, in democratic nations providing economic opportunity through technology transfer, and in the USSR by demonstrating the power of collective labour. The link between civilian and military applications of nuclear technology was very strong during the early development of the industry. The hard power of nuclear weapons on the global stage was a powerful draw for some countries, notably the United States and United Kingdom. But participants discussed what could be termed the smart power that civilian nuclear energy programmes brought, particularly at a time when the established European empires were crumbling.

Broadly speaking, workshop discussions highlighted the technocratic nature of nuclear energy policy making during the 1960s, 70s and 80s. Technical authorities were given considerable decision-making influence, and this was due primarily to a perceived trust and elevated social status afforded to engineers and the technical systems that they produced. When problems such as the management of radioactive wastes were raised, participants discussed how engineers could be trusted to eventually solve such problems. However, when nuclear waste solutions failed (and this was discussed in relation to Spain, the United Kingdom, and Germany in particular) this in turn diminished trust in nuclear engineering.

Falling public trust was further exacerbated by globally reported nuclear accidents – TMI, Chernobyl featured heavily in the discussions (with Fukushima – Daichii discussed in less detail – primarily due to time constraints within the workshop timetable). Yet the end to technocratic authority, and the rise of participatory systems of governance, was deemed to be due to the power of collective social opposition to force non-decision-making around nuclear energy site selection in key cases. The most powerful transformative effects in the engagement landscape were commonly cited as “uninvited” forms - examples where collective action through social movements of opposition forced decision-making authorities either to postpone or abandon nuclear energy sites, which in turn prompted broader civil society discussions on the nature of nuclear energy, its social and environmental desirability, and its feasibility. In the background of these changes to the engagement landscape is the evolution of media and communicative technologies. The rise of televised media and global reporting in the 1970s, and then rolling news media of the late 1980s and early 1990s, made nuclear incidents such as Chernobyl, locally relevant - it increased the sociocultural visibility of nuclear risk on the global stage.

Where the River of life method commonly ended (essentially at the present day) many of the key milestones were around the development of social media. The workshops occurred during the early days of the Trump presidency, and during ongoing negotiations over Britain's withdrawal from the European Union. The power of social media to shape public opinion, to communicate fake news, and to drown out scientific facts, was something that was heavily discussed in relation to contemporary engagement practice. When looking at engagement futures these elements were deeply important.

Part 2 - Backcasting nuclear engagement futures findings

The backcasting methodology has three principal components. The first is to identify a range of different futures. The first set of futures are those that the participants believe are likely to happen. The second are those that the participants believe are personally desirable, where desirability was defined in normative ethical terms. Participants engage in the process of moral imagination - they must first imagine the future that they want, undergo an internal deliberation about why they want that future to happen, and then they must then articulate the desirability of this future and justify the choice through dialogue. We can understand this process of imagining desirable futures as one of dramatic rehearsal. In the work of John Dewey, the concept of dramatic rehearsal refers to a type of deliberation that has value when people find themselves in indeterminate situations. These are situations in which there is considerable decision-making uncertainty: it is not clear how to act, what to value, or which ends to pursue. The purpose of the workshops is to encourage participants to question existing routines, norms, values, roles and responsibilities. Imagining the future "destabilizes" the status quo – it encourages participants to embrace the novelties introduced by new developments in science and technology, and new ones that are not yet in place (Krabbenborg 2013, Cotton 2013), and it encourages both utopian and dystopian thinking about futures, to imagine the New forms of political governance, new structures of social organization, new social practices and new problem-solving capabilities. We can understand this process of imagining desirable futures as a dramatic rehearsal, in the sense that workshop participants must then undergo the 'work of discovery' (Fesmire 2003, Dewey 1982, Lubling 1999): an attempt to find out, by inquiry, imagination and experimentation, what is at stake, which ends to pursue, and what to value.

Imagined futures are necessarily personal: they reflect the individual values of the participant as expressed in group dialogue. However, there are a number of emergent themes from examination of the workshop outputs (the listed items on sticky notes for example) and the expressions shown in the qualitative data from the recorded discussions. In this analysis, we examine the dramatic rehearsal of backcasted futures through the development of a range of common scenarios. These scenarios are constructed to define the process of dramatic rehearsal within the workshops. They can be described as "applied fictions" (Bell et al. 2013), i.e. visionary narratives which provoke dialogue about the direction of nuclear energy engagement futures that are grounded in analysis of the qualitative data. Storytelling is a central ingredient in such scenario development (Burnam-Fink 2015). Our aim in this section is to develop the overarching *storylines* for the desirable futures identified across the range of workshop contexts. The concept of storylines (Hajer 1995) (or alternatively master frames (Snow and Benford 1992) or dominant discourses (Fairclough

2003, Jäger 2001)) is applied in the social sciences to describe common worldviews and shared ways of thinking and discussing a topic, and the ways in which these "capture" the narrative around the issue under consideration. In the following analysis, identified actors (the stakeholders) are first mapped out. Second, the backcasted futures to 2050 are described in terms of actions and the underlying conditions (assumptions) that underpin them using this type of narrative approach. In each narrative, the common features across workshops are aggregated and described as short 'vignettes'. In the next section, specific action plans to meet these desirable futures (working from the present to the future) are discussed.

Mapping stakeholders

The first area of common ground across the workshops, concerns the types of actors that were identified by the participants. The stakeholder mapping process presented in figure 4 is an amalgamation of the identified actor groups across the Barcelona, London and Munich sessions. These are categorized under five primary headings, with subheadings for individual stakeholder groups listed. The five commonly identified stakeholder interest groups are:

- Citizen stakeholders (which we have termed 'publics')
- Industry
- Governmental bodies
- Experts
- Third sector organisations

We have presented a conceptual map of the identified actors in Figure _, and presented some indicative relationship mapping through a series of arrows between each of the individual groups. This is based upon the concept mapping done by participants and facilitators in the workshops, and gleaned from how stakeholder groups are discussed in the workshop dialogue.

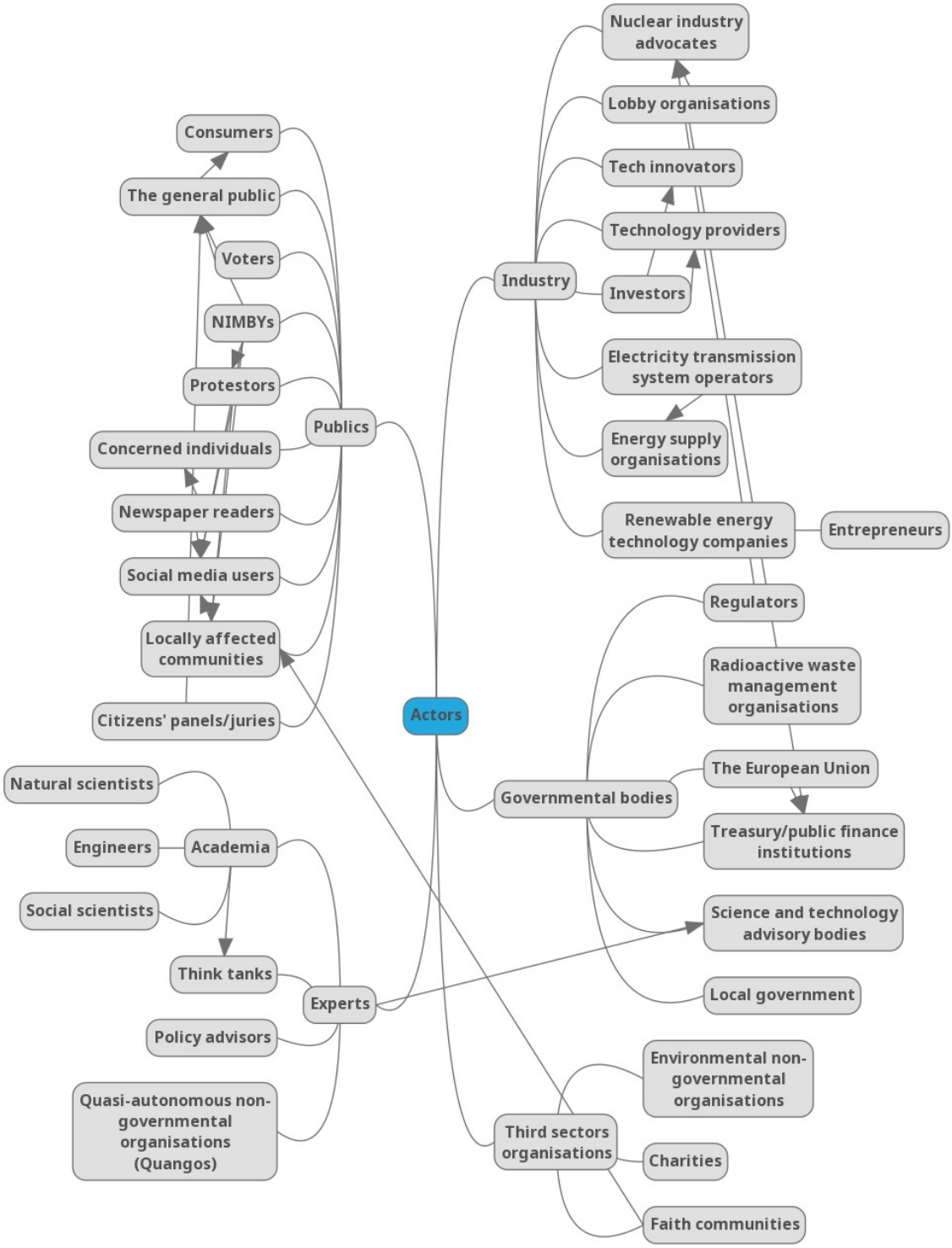

Figure 4 Stakeholder map of identified actors

Narratives of backcasted futures

Technological futures

The examination of desirable technological futures was a key facet of all of the discussions across the workshops. Participants engaged in a process of participatory technology assessment – they worked to identify priorities and to improve environmental sustainability, cost-effectiveness and wider benefits of nuclear energy technology policies and innovation strategies through their discussions. One notable finding is that nuclear energy was rarely discussed in isolation from other forms of energy technology, nor was it discussed in isolation from other aspects of the nuclear fuel cycle. We can understand this findings as a form of "opening up" and "broadening out" of technology appraisal. Participant dialogue on technological futures functioned to illuminate options, uncertainties and ambiguities. Participants considered the wider political debates about how nuclear energy is, contrary to popular representation in the media, *not a binary decision* (for-or-against), but far more nuanced. The future of nuclear energy engagement raised questions about different social interests, values and knowledges (Ely, Van Zwanenberg, and Stirling 2014), and how nuclear innovation fits in a broader pattern of decarbonisation, climate change commitment, renewable energy technology development, alternative nuclear futures (notably concerning fusion technology) and changes to land use and environmental protection brought about by broader lifestyle changes. Such a 'broadening out' of technology assessment to broader social scrutiny required the participants to articulate systems thinking and national-international problem scales (Pidgeon et al. 2014). By examining the 'broadening out and opening up' of nuclear energy engagement futures, we can identify a number of distinct themes.

Technological, geographical and governance scales

As a technology assessment process one of the common features was an emphasis upon *multi-scalar energy governance*. The primarily governance scale that participants identified for guiding nuclear energy policy was at the European Union-scale. As mentioned in the Barcelona, London, and Munich workshops, the European Union's Energy Roadmap 2050, and domestic transition laws in Spain (discussions around what would eventually become the Climate Change and Energy Transition Law), France (Act of 17 August 2015 on energy transition for green growth), Germany (Energiewende), United Kingdom (Climate Act 2008, Electricity Market Reform, and current Industrial Strategy) were commonly used as the means to frame possible nuclear energy futures, and the processes of political engagement that would make such transitions happen. Current domestic legislation on energy transition was informed at the member state level by this supra-national framework. Even under Brexit

conditions, participants were keen that the UK align its climate change and decarbonisation priorities with European activity, recognising that joint collective action within a pan-European framework was a desirable future outcome.

One of the key engagement processes was deemed to be a local-to-global collective action on climate change. Collective action is desired universally across the workshops – in the sense that there was agreement that European citizens have a *common but differentiated responsibility* (Rajamani 2000) to act in reducing their greenhouse gas emissions, and that this responsibility required action at the individual, local community, regional, national, supra-national and international scales. Nuclear power was recognised by some as playing a role in this *regional-national*-scale action on climate change - that Government engagement with multi-national finance and technology investment would help contracts for new nuclear build, which when replacing fossil fuel-based power stations met the ethical requirement for an environmentally sound solution. Though this was a desirable future for some, there was also recognition that nuclear power would not be a *panacea* for decarbonisation of electricity systems, because participants did not argue for a 100% renewable solution. The reason for this lies in the geographic and governance scales of nuclear power. Requirements for cooling, minimum distances from major population centres, and the additional infrastructure required for grid connections were significant factors that were mentioned in limiting the appeal of 3rd generation reactor designs. The nuclear power-as-mega-project also had limited support due to the time frames involved. The lead time for investment, planning, construction and operation was deemed by some (specifically in London group 2, Munich group 1) as being too long given the urgency of multi-scalar climate action.

Governance across Europe was highly differentiated. For some, the desirable future was a pan-European super-grid – that sharing electricity across borders is facilitated by nuclear power, given its potential to provide consistent baseload generation (in the way that an intermittent renewables approach to electricity generation would not). The European super-grid idea (primarily discussed in Barcelona group 1) required stronger European integration. The underlying assumption at the heart of this technology solution was an increasingly federalised Europe, that given then-current Brexit negotiations (the workshop was held in late 2017), seemed like a possible outcome only if the remaining Member States opted to renew and accelerate the integrationist policies up to 2050. The pan-European super-grid approach has considerable appeal for some, as it would allow certain member states with higher levels of nuclear expertise and engineering capacity to contribute, whilst others (notably Germany) that have domestic policies that are hostile to nuclear development can continue to contribute through renewables generation. This would mean a “division of labour” on decarbonisation transition that could be achieved through supra-national coordinated action.

At the other end of the spectrum, was an emphasis upon micro-grids. Micro-grids are a form of decentralised and localised energy production primarily associated with small-scale domestic renewables, such as wind, solar photovoltaics, micro-scale combined heat and power, and geothermal energy. However, there was considerable discussion in Munich and London workshops about the potential for small-modular reactors (SMRs) within a decentralised electricity system at the micro-scale. The major desirability factor for SMRs is local-regional self-sufficiency and carbon reduction. Small, isolated municipalities could have access to secure electricity through SMR technology, reducing the carbon footprint of remote, rural locations. This was seen as having two main potential benefits. First, it was deemed beneficial for meeting sustainable development goals of clean and secure energy for the poorest communities in the developing world. The exportation of SMRs was deemed as a possible solution to this challenge as it would reduce air pollution risks associated with coal fired power stations and domestic cooking arrangements using charcoal (which produces particulate emissions that are bad for respiratory health, leading to excess deaths). Rural electrification was deemed as a key sustainable development policy priority, and SMRs were posited as a potential solution to meeting those needs. Critics, however, noted that a secure and safe waste management solution would also need to be implemented, given that many developing economies may not have the stringent regulatory capacity to protect public safety. Other issues such as domestic nuclear engineering expertise within developing countries and anti-nuclear proliferation concerns would also need to be addressed. Second, the benefit of SMRs was discussed in relation to other local applications including high energy-intensity industries such as a steel, cement or glass manufacturing. Participants in the Barcelona and London workshops argued that such industries could improve their self-sufficiency and ease the burdens upon grid connected electricity production. Though nuclear energy was by no means universally supported by all participants, these specialised small-scale applications garnered considerable support. Rather than the nuclear energy- as megaproject (i.e. with multi-billion Euro costs), SMRs were deemed to be desirable because they could be delivered on time and on cost, in a way that third generation reactor technologies were deemed not.

As a matter of engagement, as London group 1 noted, the move towards micro-grid renewables and SMRs would provide citizen ownership and investment in nuclear energy. Local or co-operative models of SMR ownership supported by laws to allow co-ops to sell electricity directly from producer to consumer (i.e. local energy market trading) would be potentially beneficial to local economic growth and development, and would have greater levels of societal acceptability. This is because individuals would have a clear stake in investment and development outcomes, and so models of investment around cooperatives, community owned energy, and co-owned investment models with public

authorities (public-private partnerships at the local-regional scale) were deemed by some to be a useful engagement solution. There is evidence that local ownership and investment improves the sense of energy citizenship amongst locally affected site communities. Evidence from community owned renewable energy projects has shown that co-ownership can potentially improve local uptake and acceptance of controversial energy technology projects (Catney et al. 2014, Walker and Devine-Wright 2008, Cass, Walker, and Devine-Wright 2010) and overcomes a social gap (Bell, Gray, and Haggett 2005) between acceptance that a technology is necessary (in general) but not desired locally (what is sometimes referred to pejoratively as the not-in-my-back-yard, or NIMBY, problem). It was recognised that this was a potential means to engage communities in trust building. Co-ownership provides community oversight and funding choice, increasing the capacity of what could be termed *energy citizenship* (Devine-Wright 2007, Flynn, Bellaby, and Ricci 2008) or *energy democracy* (Morris and Jungjohann 2016) – public actors become active producers and managers of energy technologies rather than simply passive consumers. This was recognised in the London and Munich workshops as providing a potential means for social transformation and collective action. Citizens would take greater responsibility for climate change and for managing environmental risks if they had a direct say in investment and operational decisions for smaller-scale nuclear projects.

Sustainable transformation in societal values

Related to the previous point about energy citizenship, amongst those that self-identified as anti-nuclear, there was considerable discussion around the transformation of social values away from consumptive lifestyles towards environmentally aware and socially conscious ways of living. Decarbonisation is of course one of the key goals amongst supporters of sustainable living as expressed within the workshops. Some of the changes required infrastructural investment and changes in resource use. There were repeated calls for government divestments from fossil fuels (Barcelona group 1 described such a commitment as an ethical change akin to the abolition of slavery), for governments to move away from gas as a transition fuel, to promote research and development in renewable energy technologies – particularly around mass production and efficiency gains, to move towards widespread electrification of the economy (including heating and transport). Under those conditions, particularly increased electrification, nuclear energy was seen as having a positive impact upon sustainable outcomes for both developed and developing economies.

However, others viewed desirable engagement futures with nuclear energy in a broader sense of rethinking personal values, identities and social practices in greater harmony with nature. This meant a rethinking of engagement with

technology not simply in terms of quantitative carbon emissions reduction, but also the transformation of values within society. Reduction in energy use was prioritised over meeting a growing energy demand with new nuclear build. It is interesting therefore to note that disagreement on the future of nuclear energy is dependent upon the extent to which participants believe that a future energy demand gap from growing electrification can be filled either with efficiency gains and more renewables, or whether nuclear energy is needed. There was no consensus on this point, which is important to examine through further research – we hypothesise that stakeholder acceptance of nuclear new build is strongly dependent upon whether individuals perceive renewable energy technologies as capable of meeting growing electricity demand in the future. Though there was agreement that sustainability should involve decarbonisation and transition – the technology deployed to make this transition happen is an area of strong disagreement.

As discussed in the London workshop however (London group 1), an important question arose: "with technology do we confuse means with ends?" Participants suggested that rather than focus upon specific technology choices, we should instead focus upon multiple and heterogeneous transition pathways to achieve sustainable development. The identification of desirable futures was described in terms of "outcomes rather than process – that we [society] wants clean air, climate security, productive lives and space for nature," (London group 1) and that multiple lines of technology development can be deployed to make that happen. There was a strong sense that we should avoid binary choices between technologies in policy making, a sentiment spurred by discussion of the recent Brexit referendum vote, in favour of deeper engagement on what desirable social futures would look like through direct democratic means. Participants viewed nuclear energy as a means to engage with publics on these deeper issues about what kind of society we desire in the future, not simply what type of energy generation technology we desire.

Education, trust and public knowledge systems

Across all of the workshops there was an expressed concern that social values around environmental protection and sustainability were contentious and poorly grounded in evidence. This was expressed both by nuclear energy proponents and opponents in the workshop dialogue. There was a concern for the development of robust *public knowledge systems* for evaluating energy technology choices in the future. Recent findings in the assessment of citizens-stakeholder backcasted visions of a sustainable Europe show an emphasis upon wide-ranging societal development through *education* (Repo and Matschoss 2018), and this finding is replicated here. Discussions centred around how to make supposedly *rational* policy decisions in an era of social media opinion-leaders, declining trust in experts, policy makers that disregard

scientific evidence, and the growth in 'alternative facts' and 'fake news'. As participants in the Munich group 2 workshop put it: "we need fact over emotion". There was expressed concern that as the nuclear industry moves beyond a secrecy model (based upon Cold War protection of nuclear knowledge) towards a participatory model in the era of 'fake news', that the quality of decisions made would be inevitably reduced. Participation was, in some cases, viewed as a threat to public safety, if decisions around energy technologies were made based upon popularity rather than a dispassionate examination of public health and environmental protection. It was recognised that public engagement with nuclear energy represents a *social contract* – publics should be engaged by representative authorities (decision-makers) but that in turn required twin responsibilities. First, it behoves governments to provide impartial information and communicate knowledge about nuclear energy and technological alternatives in a way that is "trusted, authoritative and credible" (London group 1), and secondly it requires that citizens take responsibility for their own learning, and so improve what could be termed their *deliberative capacity* (Dryzek 2009) to engage effectively.

One recurrent theme was the value of education in promoting positive engagement outcomes. It was widely regarded that citizen stakeholders have a small knowledge base from which to assess the quality of energy policy decisions. Low public knowledge about the risks and benefits of nuclear energy both now and in the future, was deemed an important barrier to the achievement of desirable engagement outcomes. A popular desirable future was one where, by 2050, public knowledge about sustainability and technology was greatly improved across Europe, and this would involve significant financial investment in education programmes from elementary/primary level to post-secondary/post-16 education, and lifelong learning outcomes for adults. In some respects this is variation on the theme of the 'deficit model' of science communication, whereby the assumption is that a lack of knowledge leads to public opposition to risk-bearing technologies (and therefore that greater education would improve public acceptance) (Allum, Boy, and Bauer 2002, Sturgis and Allum 2004). However, rather than argue that increased knowledge would improve public acceptance of nuclear energy, participants generally took a more nuanced view – that increased public education would improve the capacity of citizen stakeholders to engage effectively with industry and policy bodies, to 'speak truth to power' more effectively and thus counter a trend towards populist politics among democratic nations. As discussed in the Munich group 1, there is growing awareness amongst citizen-stakeholders about environmental problems (including those associated with energy and climate change) but there is insufficient knowledge to know what to do next. As a desirable 2050 goal, investment in education to solve these problems is deemed the highest priority.

From a nuclear industry perspective, as participants in the Munich workshop remarked, nuclear technology development is "over in Germany" but there is still a need for nuclear skills in decommissioning and waste management, and in designing reactors for other countries. Keeping nuclear competencies amongst domestic nuclear industries was seen as an important priority across all of the countries in the workshops. As technologies advance to 4th generation reactor designs this will occur at the same time that 'the old guard' of the nuclear industry retires, leaving a skills gap to implement the technology. Enhancing such skills is difficult, given that the industry is 'dying' and there is little enthusiasm amongst the youngest members of the workforce (such as engineering graduates) to specialise in nuclear skills. For some, therefore, educational engagement in the future must try to stimulate young people's interest in this field, which would be difficult under a phase out approach.

It was argued that public education should not only involve top-down education campaigns from government sources, but also improved capabilities for peer-to-peer learning and engagement about nuclear energy, the environmental and socio-economic risks and benefits. The establishment of trusted peer networks for knowledge exchange was deemed an important engagement future, and the trusted and credible authorities (such as Universities, scientific societies, and in some cases environmental non-governmental organisations) were suggested as facilitators of this type of activity.

Public education and public knowledge systems were also discussed in terms of environmental activism and broader engagement with civil society. In Munich group 1 there was discussion around the value of letter writing campaigns, engagement with elected national and local representatives, to oppositional and direct-action campaigns (sit ins, marches etc.) as a means to stir public dialogue on energy technologies, and to improve the quality of nuclear energy decisions (the expression "shining a light on the topic" was used).

We can see therefore that education and public knowledge are important facets that can be mobilised for different ends. Firstly, education is necessary as an engagement tool in the maintenance and enhancement of core nuclear competencies which will be necessary for the industry to expand *or* contract (as decommissioning and waste management skills are needed urgently). Secondly, education is needed to improve the core competencies of citizens in engaging in broader questions about energy technology choice, and sustainability outcomes, to counter an 'alternative facts' approach that values opinion and scientific evidence equally. Thirdly, education as peer-to-peer social learning (Friedmann 1984, Bandura 1977) is important in the context of societal transformation to sustainability – facilitating trusted and credible information among peer networks was deemed a necessary activity for effective engagement with nuclear power over the longer term.

Promethean technology solutions

Dryzek (1997) identifies a discourse of environmental management defined as *Prometheanism* which describes an environmental orientation which perceives the Earth as a resource whose utility is determined by human needs and interests, and where environmental problems can be overcome through human innovation. Promethean discourse is a description of the social psychological processes by which participants imagine technological innovation can resolve environmental, social and economic problems caused by unsustainable energy use, and (for some participants) of those problems caused by nuclear power (notably waste and accident-related risks).

Demonstrated within the workshops was a strong technological optimism or *meliorism* concerning developments not only in nuclear fission, but also in energy storage, mass production of renewables, hydrogen, and notably fusion energy. There was a strong sense repeated across the workshops that by the time the current generation of nuclear reactors in development or construction is brought online, they are likely to be superseded in cost and efficiency terms, by disruptive new technologies. As with the discussion of the histories under the River of Life session, there was an emphasis upon individuals – particularly pioneers and entrepreneurs (Elon Musk was mentioned specifically) who look to innovate in energy storage, micro-renewables or energy-efficient building materials. These innovations over the span to 2050 were considered the major threats to the nuclear industry, as they were deemed to make nuclear energy obsolete.

The obsolescence of nuclear energy was not, however, universally agreed. As mentioned above, smaller scale SMRs were the most desirable nuclear energy transition technology, but also new fission technologies such as fourth-generation reactor designs were popular among some stakeholders (including sodium fast reactors, and molten salt reactors). These were popular for a number of reasons. Firstly, the passive safety of new designs was argued to resolve many of the public fears that exist around Fukushima-Daichii-era nuclear incidents. It was argued that molten salt reactors would be unable to 'go critical' in the same way that older boiling water reactor designs could potentially do. Some argued that by communicating passive safety effectively, 4th generation designs could avoid the public opposition problems associated with the previous generation of nuclear reactors. Secondly, 4th generation designs were argued to have the capacity to stimulate a hydrogen economy to innovate in other areas of sustainability transition (such as nuclear-produced hydrogen to power cars). Though widespread adoption of hydrogen-powered domestic vehicles was deemed unlikely, some participants identified a niche for hydrogen-powered haulage vehicles (for example) which would rapidly decarbonize supply chains for food, commodities and other goods. Thirdly,

political commitments in some countries such as the United Kingdom towards nuclear new build and the growing importance of business innovation and industrial strategy were seen as key drivers for 4th generation "technology push" over the next 30 years. Technology innovation in this sector is thus dependent upon political will to fund research and development in Universities and to aid technology transfer capabilities to bring designs to market fast enough to meet GHG reduction targets in law, and to ameliorate climate change over the next century. Fourthly, a major driver was seen as the rapidly changing political conditions (notably Brexit, and an increasingly antagonistic relationship between Western Europe and Russia) which is creating the desirable conditions for new nuclear build (specifically 4th gen and SMRs) to expand in the next two decades in order to meet energy security of supply goals and energy poverty alleviation under increasingly volatile fossil fuel prices.

The final promethean solution that was discussed in detail, is nuclear fusion. The primary technology under discussion was the International Thermonuclear Experimental Reactor (ITER) in France. This relates to European-scale nuclear energy governance mentioned above. Europe was seen as a leader in fusion energy design and technology, though this is seen as a 'race' with China and the USA to bring viable technologies to market. European governance and supra-national engagement with the science and technology development was seen as an appropriate level with which to engage civil society with fusion at this point in time. There was a sense that fusion was still '50 years away' (and there was discussion about how 50 years ago, fusion was deemed to be 50 years away). In short, there was concern amongst some participants that focus on fusion might lead to no actual viable low-carbon transition at the end, and so given that we have reliable designs for fission reactors now, the urgency of climate change makes investment and deployment of fission a high priority. Alternatively, other participants highlighted how nuclear fission would make a useful transition or 'bridge' technology (as was mentioned in the Munich workshop group 2) to a fusion-powered world given the level and intensity of scientific research into fusion globally. As an engagement issue, it was recognized that until a viable technology was developed, engagement with publics on fusion would be difficult given the largely hypothetical nature at this stage (mirroring the findings of Prades López et al. 2008). Others argued however that opening up dialogue around fusion-futures would provide vital citizen input into social and environmental dimensions of the technology. Structuring a responsible research and innovation agenda around fusion technology was argued to be the first goal of a backcasted fusion future.

Part 3 - Planning and policy making for nuclear engagement futures

In this final section, we discuss a range of nuclear energy in society policy and practice solutions drawn from the foregoing discussion of backcasted futures, and from suggestions drawn from the Dotmocracy™ sheets. The Dotmocracy sheets encouraged participants to forward simply-worded policy and practice strategies, then comment on the opportunities and threats that these pose, and to score or 'vote' upon favourites. The voting process is not demographically representative and so doesn't provide an accurate weighting of options (in the way that a multi-criteria decision analysis or nominal group technique would). However, these scores are used as indicators of stronger and weaker proposals.

As before, we present the policy recommendations as simple narratives on desirable solutions, based upon our analysis of the workshop findings as a whole. The idea in this final section of the workshop report is to present ways forward – practical planning steps to improve civil society engagement with nuclear energy.

Establish global education initiatives around energy alternatives

Irrespective of participant opinions on the desirability of nuclear energy within society, there was a consensus that public education and engagement on energy and sustainability could be greatly improved within Europe. There was concern that rapid empowerment of 'thought leaders' on social media had undue influence upon public understanding of science and technology, and in shaping public values. Evidence based policy was deemed to be best implemented when citizens are knowledgeable and motivated to scrutinize political decisions over energy futures. The key issue for engagement futures is *empowerment* through education, public knowledge systems and facilitated social learning, rather than trying to achieve public acceptability of nuclear energy through deficit-model assumptions that increased knowledge will naturally stimulate public agreement with engineering authorities.

The primary policy solution is to establish which individuals and organisations are deemed trustworthy, credible, impartial and knowledgeable enough to communicate this information, and facilitate knowledge exchange. Scientific societies (e.g. the Royal Society, German National Academy of Sciences, US National Academy of Sciences etc.) could play a key role. Public lectures such as the Royal Society Christmas lecture series, or documentaries produced by reputable scientific authorities (Prof Brian Cox was mentioned in the UK context), would be one relatively simple and cheap solution to improve engagement outcomes overall by forearming citizen stakeholders with

knowledge in advance of a more comprehensive direct democratic engagement process (discussed below).

Such supra-national educational engagement would also have the benefit of stimulating interest amongst young people in pursuing nuclear career pathways, helping to keep nuclear knowledge current. This would benefit either pro- and anti-nuclear proponents, as nuclear skills have application in radiation protection science, decommissioning safety and waste management environmental protection as well as in power station development. Nuclear skills are therefore necessary even under conditions of phase out or moratoria on new build. This would provide societal flexibility in dealing with both new nuclear build (e.g. UK) and post-nuclear societies (e.g. Germany). Transfer of skills through European knowledge networks (Marie Curie fellowships, Erasmus schemes etc. for students and fellows), or nuclear industry associations (WNA for example), is a policy priority in the context of Brexit, and potentially contracting opportunities for knowledge exchange within the industry.

Establish a mechanism for long-term nuclear waste knowledge sharing

Similar to and related to point 1, is a need for knowledge sharing and best practice on nuclear waste management processes and decision-making procedures. It was recognized that geological disposal is becoming increasingly standardized through shared technology platforms, notably the Implementing Geological Disposal of radioactive waste Technology Platform (IGD-TP) within Europe (Van Goethem 2010). However, no such common platform is identified for engaging with heterogeneous publics on the issue of radioactive waste disposal in deep geological facilities, nor is there a systemic communicative structure set up for engagement over the long-time frames of radionuclide decay. As Fuji-Johnson (2008) argues, deliberation should not only occur at just one or two time frames early on in the planning process for a radioactive waste management site. Incorporating the needs and welfare of future generations is crucial from a sustainable development perspective. However, deliberative decision-making assumes that current generations are capable of making decisions that will be de facto agreeable to future people. A key policy priority in defining desirable engagement futures, is to set up the infrastructure for long-term engagement. Though there is considerable innovation in participatory methodologies for evaluating radioactive waste management options (Sweden was held by participants as an exemplar in voluntarist site selection and community engagement), maintaining these engagement practices over long-time frames has received considerably less attention and as such is a key backcasted engagement future to pursue. These might be standing forums such as citizen's panels, funding for self-organising grassroots organisations to maintain community governance, and/or legislating within radioactive waste management decisions to revisit options at multiple future time points

(sometimes referred to as a 'stepwise', or incremental decision-making process Pescatore and Vári 2006, Cotton 2017).

The desirable future engagement practices must also consider the role of long-term site monitoring and retrievability of wastes from deep geological disposal facilities. There was strong evidence of support for a *guardianship* model of long-term radioactive waste management, whereby host communities act as stewards of site facilities over long time frames. Providing adequate resources for monitoring and retrievability, community compensation mechanisms over multi-generational timeframes, and continued democratic renewal over multiple decision points were agreed to be desirable engagement futures. Effective future engagement will also involve communication of risks in the context of language change and future cultural barriers to understanding. Further research and implementation of these cultural symbols of risk communication is needed. This is because decisions must be made about how to communicate radiological hazard information in a way that will be understandable in 10,000-100,000 years' time so that future human intrusion (intentional or unintentional can be avoided). Research into the intelligibility and durability of warning markers for long-term nuclear waste storage sites is required to prevent inadvertent human intrusion in the distant future (Lomberg and Hora 1997).

Engage in responsible research and innovation around nuclear fusion

Though the primary focus of this research has been upon fission technology-related engagement futures; it is clear that, for many participants, fusion is the technological future that is desired. The ITER programme and its counterpart 'Tokamak' projects (devices which use a powerful magnetic field to confine a hot plasma in the shape of a torus – the current leading fusion reactor design, see: Luxon 2002, Artsimovich 1972) in China, South Korea and the USA were discussed in detail. What is clear is that engagement processes around fusion are considerably less *sophisticated* than those around fission technologies, primarily due to the immaturity of the science and technology, and the relative socio-cultural invisiblity of nuclear fusion science within public consciousness (for example: Horlick-Jones, Prades, and Espluga 2012, Simon 2001).

Within European research frameworks, including Euratom, the Responsible Research and Innovation platform is now well established. Under EU funding frameworks, RRI involves research and development practices that bring together multiple societal actors (including but not limited to researchers, citizens, policy makers, business, third sector organisations). The aim of RRI is to provide *upstream* engagement with technology programmes. This involves early involvement through exercises such as backcasting, foresight analysis, and lifecycle environmental assessment. The aim is to bring diverse stakeholders together to assess the whole research and innovation process in

order to better align both the process and its outcomes with the values, needs and expectations of society (Owen, Macnaghten, and Stilgoe 2012, European Commission 2018).

It was clear from the workshop discussions that improving the *upstream engagement* (Cotton 2010, Mohr 2007, Pidgeon 2006) with fusion research requires additional funding, scientific and industry buy-in and sustained social scientific analysis. Understanding the societal risks, costs and benefits in advance of technological maturity will help to alleviate the potential problems that will likely occur as social movements of opposition move to halt technology implementation at the point of site selection (as seen in a range of case studies of siting processes for controverial energy technologies, for example: Whitton et al. 2017, Bickerstaff 2012, Benford, Moore, and Williams 1993, Boholm and Löfstedt 2004, Edelstein 2004).

Investigate engagement processes for 4th generation (including small-modular reactor) programmes

The nuclear fission technologies that gained the greatest support amongst participants were the small modular reactors for specialized applications in rural development, decentralised micro-grids and heavy industrial users; and 4th generation molten salt reactors. These technologies are passively safer than 3rd generation designs, have greater technological flexibility due to their smaller size and cost, and as 'new' technologies, require upstream societal dialogue in the same way that fusion research does. Investigating the unique engagement requirements for SMRs and 4th generation reactor designs is therefore a key priority (for future Euratom funding for example), given the relative social desirability of these technologies to meet sustainable transition goals. As such technologies can be deployed as local decentralized systems rather than centralised large-scale mega projects, this provides an opportunity for innovation in funding, ownership and local governance models. Investigation of opportunities for public-private partnerships, co-operatively and community-owned SMR technologies in particular, was deemed an engagement priority. The primary advantage of this approach is that it 'scales down' decision stakes for local authorities and public bodies – lead times and tax-payer liabilities are shorter/smaller and so perceived public liability risks are reduced. Moreover, the opportunity for local control through share/stock ownership, representation on project management boards, and shareholder meetings is one key means to improve engagement practice and stimulate public acceptance of nuclear energy technologies within host communities. Key learning on such local governance options can be gained from the growing literature on decentralized, community-owned renewables projects, where innovation in governance,

engagement practice and ownership has been tested (Haf and Parkhill 2017, Nolden 2013, Seyfang, Park, and Smith 2013, Bulkeley and Kern 2006, Rogers et al. 2008, Cotton 2011, Catney et al. 2014). Notable findings from this literature are that shared control and ownership improves community 'buy-in' to projects, stimulates shared responsibility and collective action on energy (so-called 'energy citizenship') and reduced planning conflict. We argue that a key priority for nuclear energy development from an engagement perspective should therefore be SMR development and implementation, based upon voluntarist models of community site selection under conditions of shared ownership and governance.

Explore appropriate mechanisms for direct democratic engagement

In the action planning of the Dotmocracy session, one of the key desired futures is to move from consultative and one-way communicative practices towards more direct forms of citizen control over energy technology decisions, siting processes and policy interventions. We can understand this as a desire for *strong* or *direct* democratic control of technology (Sclove 1995, Barber 1984, Ely, Van Zwanenberg, and Stirling 2014). The call for expanded and comprehensive democratic engagement on nuclear energy was understood in the context of *opening up* technology assessment to a broad range of alternative technologies and applications. As mentioned in the previous section, nuclear energy technology futures were steered towards specialist applications of SMRs and 4th generation technologies within local-scale micro-grids and specialist industrial applications. This requires a rethinking of democratic decision-making on technology options – providing greater opportunities for direct citizen engagement with elected representatives (including local government, planning and parliamentary bodies). Though there was a recognition in the workshops that participatory engagement was relatively sophisticated in some aspects of nuclear policy making (the Committee on Radioactive Waste Management in the UK, and the Swedish and Finnish participatory processes on waste management and site licensing respectively, were discussed). However, face-to-face methods of deliberative public engagement were argued to be limited, as they are rarely demographically representative (often representing the interests of those with prior knowledge, time, resources and cultural capital – so participants are often retired specialists in the policy area). Engagement futures were deemed to be moving online – towards faster, more integrated methods of engagement that have broader reach, stronger appeal to younger participants (who were deemed to be under-represented in sustainable energy decision-making), and with more direct access to public officials.

Though online methods of engagement were a desirable future there is a perceived crisis of trust, not only in nuclear industry authorities, experts and

scientific knowledge, but also in democratic institutions. The rise of populist and far-right politics, 'fake news' and 'alternative facts' is a major concern for future engagement practice raised by participants. It was argued that certain direct forms of online discussion in internet forums were easily manipulated (through bots, targeted social media and polarised, often offensive contributions from anonymous participants). Concerns were raised that online participatory democracy, though potentially valuable to direct democratic engagement, would nonetheless be open to 'hacking' or social manipulation. Rebuilding trust requires not only trust in traditional nuclear energy authorities and decision-makers, but engagement futures in an online world also require trust-building in online engagement mechanisms.

One potential solution that was briefly discussed in the London workshop group 1 was the viability of blockchain technology. Blockchain technology is one powerful means to enhance digital trust. Blockchain authentication verifies online communications and transactions at every step, it is a robust online accounting method that essentially eliminates the possibility of online fraud or manipulation (Beck et al. 2016, Hawlitschek, Notheisen, and Teubner 2018). Blockchain-based platforms have been applied primarily to digital economic transactions, in response to the advantages and limitations of online cryptocurrencies such as Bitcoin. However, blockchain also has relevance for direct democracy. Blockchain is described as a disruptive societal technology as it enables new kinds of disintermediated digital platforms which enable decentralised governance (Mattila 2016).

Digital electronic voting and discussion platforms are at the forefront of engagement futures, yet as Pawlak et al. (2018) argue, the most important and prevalent problems are the lack of auditing capabilities and system verification methods. Blockchain can be used to develop e-voting processes and components of a supervised internet voting system that is audit and verification capable, making it extremely useful for deliberative engagement on complex and immediate policy issues at different governance scales. For example, blockchain based discussion and voting platforms such as the Rahvaalgatuse platform in Estonia are growing in popularity. Rahvaalgatuse is a digital discussion and voting platform that allows direct access from citizens to policy-makers. Across the workshops there was a very strong call for broad, comprehensive and secure engagement platforms, and as a future policy and research programme, the investigation of digital methods that are credible, easily authenticated and provide direct citizen access to nuclear industry and policy authorities, would be a valuable approach to future engagement practice.

Conclusions

Deliverable D5.3 reports upon the results of a *deliberative experiment* (Grönlund, Setälä, and Herne 2010, Caluwaerts and Deschouwer 2014, Karjalainen and Rapeli 2015) in the assessment of *engagement* practices and social contexts in the nuclear energy sector. Nuclear energy and its relationship to the political, economic and material conditions of European states is deeply complex and rooted in the shared histories, imaginaries, discourses and political ideologies of the countries in which the technology was developed and deployed. As previous deliverables have discussed, issues of stakeholder risk perceptions, economic incentives, geopolitical relationships and governance models have influenced the engagement practices of nuclear industry, regulatory, policy and civil society actors since the inception of domestic nuclear power electricity in the early 1950s (Espluga et al. 2018, Konrad et al. 2018). In this work package we extended this analysis of perceptual and societal engagement historical practices (ibid) and engagement principles (Charnley-Parry et al. 2017) through primary data collection. We performed an analysis of the qualitative data from facilitated workshops in Barcelona, London and Munich: totalling 7 groups of 7-10 members undertaking 5-6 hour-long discussions of past, present and future engagement practices across Europe. Though we make no claims for demographic representation across Europe, we have (as is common to qualitative analysis) captured a diverse array of opinions and expertise, to provide *rich descriptive (*Miles and Huberman 1984) analysis of the perspectives found within our sample. The workshops were designed to assess stakeholder perceptions of the cognitive links and subjective representations emerging between past, present day practices and “idealised” futures for nuclear energy in society across Europe – encompassing perspectives from nations that developed nuclear energy programmes under both democratic and formerly-authoritarian regimes; and to capture perspectives from a range of professional backgrounds including the nuclear energy industry, non-governmental organisations, policy bodies, third sector, academic, and citizen-stakeholder groups.

Through a process of iterative testing and development, we presented and applied a series of bespoke engagement ‘tools’ to structure facilitated workshop sessions We have developed and adapted methods from the literatures in participatory learning and action ("The River of Life", see for example: Bozalek and Biersteker 2010), in backcasting (e.g. (Quist and Vergragt 2006, Bibri 2018, Repo and Matschoss 2018) and participatory decision-making ('Dotmocracy', alternatively known as 'Idea ratings sheets', see in particular: Hidalgo 2018, Diceman 2014). The methods deployed were consonant with the ethos of the HoNESt project – we have developed a co-produced and participant-led process of engagement, which can, in turn be adapted and applied to any participatory technology assessment process where the technology in question raises can be considered *socially and ethically contentious* (Cotton, 2014). With

this in mind Rowe's evaluation report of the workshop *process* in the next part of D5.3 is instructive to the application of these methods in practice.

One of the unique features of the backcasting analysis that we present, is that it is grounded in the understanding of memory and history surrounding the development of the nuclear energy sector across Europe. We recognise that imagining the future is cognitively taxing for participants (Levin 2004). Projecting from the present into the future, and thinking through the ethical consequences of such futures is difficult because, as *construal-level* theorists in social psychology have argued, the further away something seems (this is true temporally and spatially), the more abstract it feels (Trope and Liberman 2010). The basis for the workshop design was to structure the deliberative process in chronological terms – allowing easy *mental* comparison between past, present and future. We argue that the value in this methodology lies in the capacity for participants to engage in both "past thinking" and "future thinking" contiguously. Thus, this methodological 'toolkit' of engagement activities helps to overcome the problems of overly abstract thinking. The construal of engagement futures grounded in the past, helps to move participants from abstract to concrete visualisation (Fischhoff 1999, Förster, Friedman, and Liberman 2004) through comparisons, hypothetical scenarios, and practical action planning.

When examining past engagement practices there are a number of key findings. The first is that in terms of stakeholder perspectives on past engagement practices, the overarching factor is the political ideology of the nation state and the trans-national ideological structures of the Cold War that have the strongest influence. Under authoritarian regimes of Warsaw pact countries, the socialist political governance models allowed for direct citizen engagement with the state, though this had little influence upon decisions over nuclear energy. The ideological 'push' of Atoms For Peace, and the soft power that nuclear energy grants to nations that possess it, overcame local concerns (where they existed) about specific facilities. Nuclear power has been construed as a national-level *imaginary* that embodies state power, national identity, ideas of self-sufficiency and technological prowess that marked the *modern state.* This was true in both democratic, formerly fascist and formerly socialist states. We can understand nuclear energy development therefore in a *socio-material* context – concerns about 'peak' fossil fuels, declining reserves, ecological limits, economic shocks (such as the oil crisis), and competing technological regimes (between East and West during the Cold War) all had a compelling effect upon the types of engagement that emerged, the types of technologies (such as close ties between civilian nuclear energy and nuclear weapons during the industry's inception in many European states), and ways in which political authorities involved (or more often didn't involve) citizens directly in decisions.

Engagement with nuclear energy is therefore a part of (and indeed we argue a driver of) democratic renewal. Though decisions were 'top-down' in

authoritarian political regimes due to the nature of the institutional structures of decision-making, in democratic nations it was the Cold War and the ties between military secrecy and nuclear energy that suppressed opportunities for civil society involvement in nuclear energy decision-making. Citizens were commonly represented by proxy, through experts of various types. Public safety was perceived to be understood as a matter for technical authorities, and the biggest opportunities to 'open-up' (Stirling 2004) political dialogue on nuclear energy commonly occurred after the publication of major reports and committee findings chaired by scientists in Western European democratic countries. This has since been expanded to include citizen voices, as the *participatory turn* in nuclear energy decision-making (Bergmans et al. 2015, Saurugger 2010, Sundqvist and Elam 2010) has created a culture of citizen involvement in techno-scientific decision-making.

When projecting engagement contexts into the future, our research finds a range of recurrent themes. The first concerns the role of nuclear energy in shaping societal values over sustainable transformation. Nuclear energy was perceived through myriad heuristics, biases and subjective associations by our different participants. The symbolic interactions that surround debates over the renewal of nuclear energy remain highly polarised between for-and-against positions, as we might expect given the controversial nature of the technology. This polarisation concerns the extent to which nuclear energy influences sustainable values amongst broader populations. There was widespread recognition that climate change is an imminent threat to society, that global collective action is required, and that transformation of electricity systems towards low carbon alternatives is an urgent facet of a global response. It is interesting to note, however, that although there was no consensus on nuclear energy as a solution to this problem amongst participants, there was *some* recognition for specific applications for nuclear energy technologies, such as small modular reactors (SMRs) for specific applications such as in remote or isolated communities, for specific industries or sectors of society (such as large energy consumers like steel manufacture, isolated research facilities or hospitals), and towards future nuclear fusion technologies that may emerge and these two aspects remain a key area of future work into public perceptions of nuclear energy technologies.

As an engagement practice, smaller scale nuclear technologies were generally preferred as part of decentralised micro-grid systems, and the technological future for nuclear energy was primarily framed in those terms. Of great focus were the scales of governance through which nuclear energy is decided. There was recognition that the history of nuclear energy and society is dominated by technocratic decision-making processes - top-down decisions driven by expert committees, with decisions only opened up after committees have made their conclusions. As shown in other studies of large technical systems (Goldthau 2014), we find the participants recognised that large-scale nuclear energy is

symbolically representative of a centralised system of decision-making authority as well as a centralised system of energy generation. As the future of engagement was generally agreed to be one of greater flexibility, democratic capacity, transparent information exchange, rapid knowledge dissemination, and local citizen involvement, it was argued that nuclear energy *should be* reshaped to fit this governance model. Thus, scaling down the technology to the *municipal* level through SMRs, alternative nuclear technologies (such as thorium reactors etc.) was a common feature of nuclear engagement futures.

A recurrent theme around engagement is that of education, of knowledge transfer, and of systems of decision-making. It was generally agreed that more education, not only around nuclear energy and its impacts, but also about ways to transform society to become more sustainable overall, were of a high priority. Yet with the rise of social networks of knowledge dissemination, fake news, distrust in scientific and technical authority, and increasingly polarised political environment (with the rise of the alt-right for example), there was considerable concern that *engagement itself* was untrustworthy. In an era when facts cannot be trusted because of a deluge of misinformation through vested interests, and the biases and heuristics that individuals employ to understand information, there was concern that a future for engagement would become a dystopian world of *relativism* – where truth could not be discerned from propaganda. When it comes to engagement practice an increasingly online world of debate, providing systems of trustworthy and accountable knowledge dissemination around nuclear energy are a high priority. For the nuclear industry itself, this requires a widespread adoption of principles of ethics of transparency within current and future engagement practice. In political situations where nuclear energy is not trusted by citizens due to concerns over nuclear safety, environmental risk, weapons proliferation, and the secrecy of the past, it becomes increasingly important in an era of fake news that industry bodies, public authorities, and their critics (including environmental non-governmental organisations and protest groups) be truthful, base their arguments in sound evidence, and avoid polemic.

A desirable future of nuclear energy and society has multiple facets. It is one concerned with reducing the “decision scales” surrounding technological development and the provision of local decision-making control. It concerns greater integration of smaller scale nuclear energy technologies which can be integrated into decentralised energy systems. It involves broad commitment to transparency and fair argumentation in the face of misinformation and vested interests. Finally, it concerns the development of secure online platforms for transparent deliberation which must be maintained over the life cycle of nuclear energy projects and beyond, given the long time-fames of maintaining nuclear safety from decommissioned sites and radioactive waste management facilities.

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Evaluation of the HONEST Stakeholder Engagement Events

Introduction

Three stakeholder engagements events were conducted for HONEST in Barcelona (September 2017), London (January 2018) and Munich (April 2018). These events included both a dissemination element, in which key findings from the project were communicated to stakeholders through presentations, and an interactive element, in which stakeholders were involved in a facilitated 'backcasting' exercise (for Work package 5). The Barcelona event took place over two days (or more accurately, one-and-a-half) and followed a 'summer school' at the University Pompeu Fabra; the London event (at the Science Museum) and the Munich event (at the Deutsches Museum) each took place over one day. See the previous sections of this report for more details including programs. In order to learn from these exercises, and to confirm the 'validity' of their processes and findings, a light-touch evaluation was conducted, the learnings from which informed the nature and conduct of subsequent events.

The Evaluation: Principles and Process

'Evaluation' is an important concept given that engagement events tend to cost money (in this case, European taxpayers' money) and can have significant policy implications. Generally speaking, evaluation is meant to provide some assurance to relevant parties (stakeholders, policy makers, tax payers, etc.) that a process is unbiased and of good quality. However, the concept of 'quality' is not a simple one, and is nuanced. In this section, the issue of 'what is evaluation?' is briefly explored.

Just as there are uncertainties as to how best to conduct stakeholder engagement processes, there are uncertainties as to how best to evaluate these. One major area of debate in this area is whether it is possible to derive a generic evaluation framework that can be used to evaluate all instances of stakeholder engagement, or whether each instance of engagement is so specific in its aims that this is infeasible. Rowe and Frewer (2004) have argued for the former: they contest that, though the aims of any particular event might differ at one level, they are similar at a higher level. That is, all instances of 'stakeholder engagement', and its relative, 'public engagement', seek to achieve similar goals, and that similarity is part of what defines them. Various authors have sought, then, to stipulate what those common goals might be, defining 'evaluation criteria' against which the success or otherwise of any event might be judged.

This is not the place to go into a review of different evaluative frameworks (although there are relatively few coherent examples of these). One framework, elaborated in Horlick-Jones, Rowe and Walls (2007) sees engagement events (whether involving stakeholders or the public) as *information systems*. They conceptualise the fundamental purpose of engagement as the efficient elicitation and combination of information from all parties involved to produce a comprehensive and accurate output (which may then be used by the event's 'sponsors' in whichever way they please). Thus, they suggest that one way to view the effectiveness of any engagement event is according to the efficiency with which information enters, travels through, and emerges from it, and their concern is with recording barriers – structural, behavioural (etc.) – that can lead to 'information loss' (where some of the entirety of theoretically relevant information is omitted, corrupted, mistranslated). The theoretically relevant information comprises all that which might have a bearing on understanding (and potentially resolving) the issue about which the engagement is concerned. The emphasis on identifying places of information loss (poor 'information translation') emerges because the full nature of theoretically relevant information cannot practically be known (i.e. and hence, Horlick-Jones *et al* have not suggested attempting to detail it – for to detail it would essentially be to solve the problem that the engagement is addressing). Efficient information translation therefore relies upon the presence in an engagement event of all appropriate stakeholders (who may or may not include the public) that potentially have information relevant to the problem. It requires a clear presentation of the problem, and all associated facts, to those participants from the 'sponsors' (or the 'organisers', when these are contractors for the sponsors). It requires the availability of a suitable environment in which dialogue can take place between the relevant stakeholders (suitable in terms of physical and time resources, and in terms of efficient process management, such as through one or more facilitators). And it requires suitable methods and resources to accurately and comprehensively record and combine the output from the dialogue between the stakeholders. This is the conceptual idea behind the current evaluation.

It is also important to note, however, that the different parties involved in any event may have differing understandings as to what makes that event efficient or a 'success'. One approach to dealing with this issue is to essentially ask the different parties involved what they think of the event using open, un-framed questions (establishing the participants' implicit evaluation criteria). This is an approach that Rowe and colleagues have used in a number of major past engagement events – in EU projects and elsewhere – usually finding that participant criteria do indeed mirror the main concepts of 'information translation' though often using different expressions and language.

For this project, because the evaluation was not foreseen as a specific and significant activity, and because the evaluator (Rowe) was also a member of the

organising team and was actively involved in the facilitation of the events, the evaluation was limited to an analysis of participant responses to a standard questionnaire (see Appendix 1). In a full-scale evaluation using this framework, the evaluator would normally provide additional commentary based upon use of an observation protocol as well as commentary based on an analysis of event-related documents, but these activities would be time-consuming and methodologically questionable because of the evaluator's potential 'vested interests' in the success of the events. The questionnaire (Appendix 1) includes a number of questions asking about aspects of 'information translation', as well as some more pointed questions about participants' beliefs on the success of the event in which they took part, plus open questions from which implicit evaluation criteria might be established. This questionnaire is based upon one used in past projects (e.g. the EU projects VOICES and INPROFOOD) that has been found to be useful; it is deliberately brief, in recognition of the practical difficulty in asking participants to complete long questionnaires at the end of an event and in recognition of the fact that sending such a questionnaire to be completed and returned at a later date invariably yields a very low response rate.

Responses to the Participant Questionnaire

The participant questionnaire was handed out to all participants at the end of the three stakeholder events, with a request that they be completed then and there. About 10 minutes was allowed in the respective programs for this, although participants could, of course, spend longer if they wished to do so. Typically, however, participants tended to spend less time than allotted, with a number leaving before they could complete the questionnaire (which is usual in such events). Eleven completed questionnaires were attained from each event, giving 33 responses in total. These represented approximately two-thirds of participants attending the events (accurate numbers are difficult to confirm, given that some registered participants did not attend while some non-registered participants *did*, and furthermore, at the Barcelona event a number of participants related to the project and attending to help with the prior summer school also stayed to take part).

The first set of questions asked participants whether they believed that they had *received* important information of various types, such as what the event was about, whether the aims were clearly specified, and whether participants believed that those attending were appropriate for the event (the latter question indicates the presence/ absence of other needed information, rather than anything about information communication by the organisers). All of these are important aspects, arguably needed by participants so that they have adequate information about their roles and what is expected of them. Put another way, it is difficult to argue that the *absence* of such information would in any way be

beneficial to participants and the process - that is, the absence of such information is at best *neutral*, at worst, *negative*.

Table 1 summarises the answers to the first set of questions. Participants were generally clear on what the events were about before attending, although there was significant uncertainty at the first event (Barcelona), with several participants indicating that they were not clear about event aims, and this led to changes in program design when advertising the subsequent events (to better manage expectations). Clarity in the statement of aims at the outset of events was also generally good, again evolving across the three events, so that by the final one (Munich) the team had improved their communication style and content (note the dip from Barcelona to London, which was caused by a change of event style that reduced clarity of purpose regarding the balance between information dissemination and the dialogue element).

The second two questions in Table 1 dealt with informing participants about why they and others had been invited to attend the events, and on this matter, there was considerably greater uncertainty. This is perhaps understandable, as invitations were generic through various lists and contacts rather than through direct personal invitations and so the recruitment drive varied across events, with anyone wishing to attend being allowed to do so. Nevertheless, the process of explaining the recruitment process to participants – largely to assuage potential concerns that there might have been a biased selection process – could have been improved.

Table 1. Responses to questions about provided information

Question	Barcelona (N=11)	London (N=11)	Munich (N=11)
Was it clear from the information you were sent prior to the event what the workshop was about?	Yes = **45.5%** Unsure = 27.3% No = 27.3%	Yes = **63.6%** Unsure = 36.4% No = 0%	Yes = **63.6%** Unsure = 36.4% No = 0%
At the start of the workshop, were the aims clearly specified?	Yes = **72.7%** Unsure = 9.1% No = 9.1% Blank = 9.1%	Yes = **63.6%** Unsure = 27.3% No = 9.1%	Yes = **91.0%** Unsure = 9.1% No = 0%
Was it clear to you from the information you were sent prior to the event why	Yes = **36.4%** Unsure = 18.2% No = 18.2% Blank = 27.3%	Yes = **45.5%** Unsure = 27.3% No = 9.1%% Blank = 18.2%	Yes = **54.5%** Unsure = 36.4% No = 0% Blank = 9.1%

YOU were invited?			
Was it made clear to you how the participants for this event were selected?	Yes = 18.2% Unsure = **45.5%** No = 36.4%	Yes = 18.2% Unsure = 9.1% No = **63.6%** Blank = 9.1%	Yes = 36.4% Unsure = 9.1% No = **45.5%** Blank = 9.1%

The issue of the balance of attendees is important, and so a further question asked: "Do you think the audience was appropriate for this event?" Participants were also invited to suggest participants who should have been present but were not. This issue has a bearing on the effectiveness of information translation, as missing or inappropriate participants can ensure that some important information is absent the discussions or, in the latter case, that irrelevant information is present instead. At the Barcelona event, 82% replied that they thought the audience was appropriate; at London this was only 36.4%, and at Munich the figure was back to 82% (all other respondents at the three events responded that they were 'uncertain', save for one at Barcelona who answered 'no'). This suggests that there may have been some issues with the London event. Answers to the open question help elaborate on this matter – at least on notable omissions:

- Six respondents from Barcelona answered this question, with two noting industrial or practitioner stakeholders who might have been invited (e.g. nuclear engineers), two suggesting participants from other countries (Spain and Italy) and two providing the actual names of important experts;
- Six respondents from London answered, giving a wide list of omissions, including: government representatives/regulators (mentioned by four), NGOs (mentioned by two), nuclear operators, media representatives, NIA representation, members of the public, named individuals, and a broader gender/racial/cultural mix;
- Four respondents from Munich answered, mentioning media representatives, NGOs, a wider range of stakeholders (generically) and more participants from outside Germany.

The frequent naming of government/regulator omissions at London suggests that this may have been the main source of uncertainty about the completeness of stakeholders there. Of course, some of these stakeholders are more difficult to access and convince to attend events such as this than others, but these answers are helpful in thinking on future events and indicating perspectives that might not be fully included in dialogic element.

The second component of the translation model concerns how information is elicited from the participants within the engagement process (as opposed to

being communicated *to* the participants by the organisers and, to a degree, by other participants). Good translation requires information to be fully and fairly elicited from all participants, so that it becomes available for consideration by other participants. Aspects of the design of an event, and how it is enacted (e.g. moderated) can help or hinder such elicitation and the free flow of that information within the system. Several questions addressed this aspect.

Two questions asked participants their views on whether they had been given adequate opportunity to talk – i.e. to provide information to the organisers/sponsors/other participants in return for (and in response to) the information that they had received. Table 2 records the responses to these. When asked whether they had the opportunity to say what they wanted to say, participants were generally positive, especially in the Barcelona and Munich events, where those who answered either indicated that they had said 'all' or 'most' of what they had wanted to say. The London event appeared somewhat different: although still positive overall, those indicating they had said 'all' was matched by those who had only said 'a little' ('most' was the dominant response). In this case, the presence of one highly dogmatic and knowledgeable individual within one of the break-out groups could have accounted for this (indeed, subsequent comments suggest that this was at least partly the reason). This demonstrates the need for firm facilitation of group discussions but also shows how one or two voluble individuals can unbalance discussion leading to 'information loss'. With respect to time availability, again there was an anomaly: those in Barcelona and Munich generally felt that discussion time was sufficient, but in London there was an almost even split between those who were positive and those who were negative.

Table 2: Responses to questions about opportunity to contribute

Question	Barcelona (N=11)	London (N=11)	Munich (N=11)
During the event, did you have the opportunity to have your say?	I said: All… = **54.5%** Most... = 36.4% A little… = 0% Nothing… = 0% Blank = 9.1%	I said: All… = 18.2% Most… = **63.6%** A little… = 18.2% Nothing… = 0%	I said: All… = **54.5%** Most... = 36.4% A little… = 0% Nothing… = 0% Blank = 9.1%
Was there sufficient time to discuss all that needed to be discussed?	Yes = **72.7%** Unsure = 18.2% No = 9.1%	Yes = **54.5%** Unsure = 0% No = 45.5%	Yes = **72.7%** Unsure = 9.1% No = 9.1% Blank = 9.1%

Two open questions attempted to elaborate on where there were gaps in discussions. One question asked: "Do you think there were any significant issues that were NOT discussed, but which should have been? What were

these?" From Barcelona, a couple or respondents suggested that time was an issue generally, but in terms of specific issues the only ones named were: 'the role of circular planning on energy policies and the growing scarcity of raw materials and its role on the geopolitics and therefore on energy reliability'; 'waste management'; 'the relation between nuclear and space (deep space, solar system) exploration', and 'other potential generation'. In London, the issues mentioned were: 'learning from other countries (the workshop was solely UK focused)'; 'climate change and… the urgent need for decarbonisation'; 'phase out'; 'public and stakeholder engagement in nuclear and new build and radioactive waste decisions'; 'good practice/lessons learned' from the country-by-country comparisons (mentioned by two); 'energy system issues', and, generally, 'more about what the project has found'. In Munich there were fewer concerns: one noted general time limitations, one asked about 'public opinion versus public opinion in the media', and two others suggested expanding consideration beyond Germany and comparing to other Eastern European/European countries.

A related follow-up question asked "Were there any significant issues raised at the workshop that were not resolved? If so, what issues were these?" In Barcelona, the topics identified were: 'repositories'; 'the uncertainty of climate change events on the organisation of countries' relationships and social change'; 'new technology (rather a black hole that we don't know much about)'; 'how democracy should work when thinking about the future of nuclear society (representative vs direct democracy)'; 'the difficult relationship between (democratic) government and public (that is not homogeneous)'; and 'the level of involvement of public(s) in RWM'. A couple of participants suggested that most issues were 'unresolved' because of limited time. In London, identified topics included: 'need for new reactor demonstration projects'; 'comparative learning from the country reports' (noted by two); and 'instrumetalised bias'. Three other participants suggested that there were general issues with timing, the discussion going off-topic, or there not being the relevant stakeholders (possibly policy makers) to ensure something useful would emerge from the discussions. And in Munich, the topics mentioned were limited to waste (mentioned by two participants) and implementing future visions (with a couple more noting how time limitations curtailed resolving issues fully).

Of course, time was limited at all of these events for pragmatic reasons, as it can be difficult to gain attendance of important stakeholders over more than one day, and hence not everything in the complex domain of nuclear energy in society (across many countries) could be discussed. Nevertheless, the issues identified above, over the three events, are worth bearing in mind as potential targets for further dialogue.

Another issue concerned with good translation is the adequacy with which participants' views are *understood and recorded* by event organisers. One

important process that often takes place in engagement events may be termed the 'summing-up'; it occurs when the moderator reflects back to the participants what they believe the participants have been saying - as a kind of validity check – or the participants themselves report back what was discussed in their groups. Sometimes such 'summing-up' occurs at the end of an event, sometimes after every section (question/ exercise) of an event… and sometimes it just does not take place at all (and in such cases - we would argue - this is generally a mistake, as it means a good opportunity for allowing participants to clarify their views or contest interpretations is missed). One question asked: "Do you think the summing up accurately reflected what was discussed at the workshop?" There was a distinct difference between the three events here: in Barcelona and Munich, participants were positive (in Barcelona, 82% answered 'yes' with the rest 'uncertain', while in Munich, all those who answered – seven of 11 – answered 'yes'), while responses in London were equivocal. In London, nearly half (45.5%) answered that there had been 'no summing up', while the remainder were evenly split between the other options (yes/uncertain/no – 18.2% for each). Indeed, in London the tight schedule did mean that there had been no summing up at the end of the event *per se* (there may have been elements of summing-up within the different break-out discussion groups), and discussions within the organising team afterwards revealed an unhappiness about this that led to a revision of the program for the Munich event to ensure that there would be scope for this activity (arguably demonstrating how evaluation, or at least self-reflection, can lead to enhanced event design).

A trio of questions asked more directly about the participants' opinions about the events. Table 3 shows the responses. In response to the question, 'overall, do you think the workshop was well run?', not a single participant over the three events answered 'no', and in fact, for the Munich event, every respondent answered 'yes'. Again, in terms of 'satisfaction', the large majority over all three events described themselves as either 'very' or 'fairly' satisfied, with only the London event really revealing any dissention to this. In London, around one-third of respondents indicated that they were 'neither satisfied nor dissatisfied' (a neutral rating), with a solitary respondent giving a negative rating ('not very satisfied'). In terms of 'expectations', the London event was again the least positively rated overall (two respondents indicated that the event had not lived up to their expectations), with Munich the most positive.

Attached to these closed questions were a number of open questions asking respondents to describe reasons for any negative evaluations. In line with the general positivity, there were few responses to these. One respondent from Barcelona suggested that the workshop attempted to debate 'too wide (a) topic', with another saying they expected more in-depth analysis (these issues clearly being two sides to a single problem). A single respondent from Munich also expected more analysis of the 'whys' as opposed to just the 'whats'.. From

London there were more responses: one respondent suggested that 'there was a lack of clarity in communicating the purpose, aims and desired outcomes of the workshop… (and) it was not clear how the outputs of the workshop would be used'; another suggested that 'the opening presentation was good but the workshops were problematic as they did not follow on from the comparative atomic history profiles'; and another wrote of a 'late start; inconsistent timekeeping'. In terms of expectations, one London participant 'expected more on the country-by-country comparisons' and another expected (or wanted) 'more time to be devoted to discussing the future'.

All-in-all these are a good set of results and suggest that the participants viewed the events positively, with a slight dissention in London, where the organisers had attempted to reduce a one-and-half day event (from Barcelona) into a single day, and clearly did not do so perfectly, although the learning from that event led to further tweaks to the program and processes leading to very positive responses from participants from the final event.

Table 3: Responses to general evaluative questions

Question	Barcelona (N=11)	London (N=11)	Munich (N=11)
Overall, do you think the workshop was well run?	Yes = **82.0%** Unsure = 18.2% No = 0%	Yes = **63.6%** Unsure = 36.4% No = 0%	Yes = **100%** Unsure = 0% No = 0%
How satisfied were you with the event overall?	Very = **63.6%** Fairly = 36.4% Neither = 0% Not very = 0% Not at all = 0%	Very = 27.3% Fairly = 27.3% Neither = **36.4%** Not very = 9.1% Not at all = 0%	Very = 27.3% Fairly = **72.7%** Neither = 0% Not very = 0% Not at all = 0%
Did the event live up to your expectations?	Yes = **63.6%** Unsure = 27.3% No = 9.1%	Yes = **54.5%** Unsure = 27.3% No = 18.2%	Yes = **82.0%** Unsure = 18.2% No = 0%

The first two sets of questions considered the flow of information to participants and the flow of information from (and between) participants within the workshop process (and another set looked at general perceptions of how the event was run). At the end of the process there arises the issue as to what will happen to the results/outputs, and what impact these may have – on the participants themselves, and on wider events – such as European policy. From an information translation perspective, if the results from the process are gathered into a report, but then nothing further arises from this, then information loss might be considered total, with the project being deemed a failure irrespective of how well an event had gone. Of course, impact is difficult to judge at this stage and often emerges well beyond the end of a project such as HONEST. At this

stage all that can be considered is immediate impact, and potential or desired impact. In the participant questionnaire, several questions addressed these matters, and Table 4 summarises the results from the three workshops.

One clear sign of impact is whether participants were in some way changed as a consequence of their involvement in the event. One issue is whether participants learnt anything from the workshop. Therefore one question asked: "Did you learn much from the workshop?" Almost all respondents indicated that they had either learnt 'a lot' or 'a little' (with Barcelona respondents particularly positive), with just a couple of respondents to the London event indicating that they were 'unsure' about whether they had learnt anything new (and none declared that they had learnt nothing). The higher figure for Barcelona perhaps reflects the fact that this event took place over one-and-a-half days (rather than one) and also followed on from a summer school, so it may be that some participants were thinking about the wider set of activities rather than the workshop *per se*. In general, these are a good set of figures, bearing in mind that participants comprised expert stakeholders and not simply members of the public, and hence these could be expected to already have deep knowledge on the issue at hand.

Table 4: Responses to questions about immediate or expected impact

Did you learn much from the workshop?	A lot = **54.5%** A little = 45.5% Unsure = 0% Nothing = 0%	A lot = 9.1% A little = **72.7%** Unsure = 18.2% Nothing = 0%	A lot = 18.2% A little = **72.7%** Unsure = 0% Nothing = 0% Blank = 9.1%
Did participation in this event change your views on the issues in any way?	Considerably = 9.1% Some = **45.5%** Unsure = 18.2% No = 27.3%	Considerably = 0**%** Some = **45.5%** Unsure = 18.2% No = 36.4%	Considerably = 0**%** Some = 27.3% Unsure = 27.3% No = **36.4%** Blank = 9.1%
Do you think this event will have any influence on relations between nuclear industry and society?	Yes = 36.4% Unsure = **45.5%** No = 18.2% %	Yes = **45.5%** Unsure = 36.4% No = 18.2%%	Yes = 0**%** Unsure = **45.5%** No = **45.5%** Blank = 9.1%

Another question looked at a further sign of event impact, asking participants "Did participation in this event change your views on the issues in any way?" The answers shown in Table 4 do show some significant impact: although no one indicated that their views had changed 'considerably' (which would not be expected in a set of expert stakeholders) between a quarter to a half suggested

that they had changed their views at least 'a little', with around a quarter to a third at each event declaring that they had not changed their views in any way. On the whole, this suggests that some of the information being exchanged within the workshops was compelling – indeed, an open question additionally asked: "What information (from speakers, from written material, from other participants, etc.) did you think was particularly influential on your views?" Respondents gave a wide variety of answers to this across the events, which tended to be of one of two types: some cited a particular *medium* of communication (either general or specific) as of main influence, whereas others cited a particular piece of *information* as key. Occasionally the initial presentations were noted as highly influential (or the speakers who gave them), or the group discussions were cited instead (or the views of 'other participants' within these). In terms of specific pieces of information that were influential, these included information on different countries' perceptions/ priorities and information about stakeholder engagement/public involvement.

Finally here, one question asked: "Do you think this event will have any influence on relations between nuclear industry and society?" Here, there was a curious imbalance across the events: most of those at Barcelona and even London answered 'yes' or were unsure, whereas respondents from Munich were far more sceptical: not one answered 'yes', and respondents were essentially split between those that were 'unsure' and those that thought no influence would occur. An open aspect to this question asked respondents to explain their responses. One of the main issues of concern was the uncertain 'channels of influence' from this project to policy makers, or as one put it, 'it depends on how the final output will be delivered to whom', or as another noted, it will 'depend to some degree on (the) target audience for results and conclusions and on how they are communicated, published - (whether) widely or not.' This view was expressed by participants from all three events. Other concerns from Munich in particular were that there were imbalances in those present that might undermine influence – such as too many German stakeholders (or indeed, inappropriate German stakeholders, with important experts being deterred because the event was in English), and too few representatives of industry (who would need to be involved). One respondent also noted sceptically that 'nuclear energy is a very complex subject which is mostly held on an emotional level… facts are often not taken into account.' On the positive side, a couple of respondents, though questioning the potential influence of their workshop, did suggest that the project as a whole might still have influence.

In summary, the workshops had various impacts on participants in the sense of providing them with new knowledge, while a significant proportion suggested that their minds had been changed to some degree. In terms of impact on wider policy, this, of course, cannot be judged at this point, and respondents' views were in the part conditional (i.e. it might have impact under certain conditions).

The ultimate impact of this process on policy making cannot be determined in this short evaluation, but is ultimately needed to help judge the overall success of the HONEST project.

The questions in the participant questionnaire discussed so far are informed by a theoretical concept as to what makes a good stakeholder or public dialogue (essentially, good information translation), along with a concern about event influence (which is seen as the necessary outcome of good translation of public dialogue aims). However, it is useful to ask participants in their own words what they have found good and bad about an event, as this can reveal alternative conceptualisations of the 'effectiveness' issue. The questionnaire therefore included three additional open questions that asked "Overall, what was the best thing about the workshop?", "Overall, what was the worst thing about the workshop?", and "How do you think an event like this could be improved if something similar was run in the future?"

There were a number of common themes in response to the 'pros' question - answered by most respondents and repeated over the three different events. These themes were:

- Meeting/debating with people with different views (the interdisciplinarity of stakeholders)
- Brainstorming/thinking of new things
- The focus on openness
- Different aspects of the process (the HONEST video, backcasting, the 'river of life', and particularly the group discussions)
- Catching up with an existing network
- Learning/hearing certain facts/perspectives (e.g. 'best practice principles', the history of UK nuclear power, short country reports)

Interestingly, these issues generally speak to learning, the exchange of information, the processes by which information exchange was enabled, and the nature of the people (information sources) involved – all of which concepts easily overlap with the 'information translation' perspective taken in this evaluation.

With respect to the cons, slightly fewer responses were attained, but these were of a greater variety than the 'pros' and seemed more specific to the different workshops. The negative themes noted (with event location in brackets) were:

- The need to move around for the group sessions (Barcelona)
- Too diverse and not concrete enough (Barcelona)

- Difficult to image the future (Barcelona)
- Too focused on ideals without recognising (societal) realities (Barcelona)
- Lack of clarity about overall purpose and outcomes (London)
- Discontinuity between the dissemination and workshop elements (London)
- One person dominating discussion/ 'interfering' with opposed arguments (London)
- Non-relevant contributions (London)
- Not enough discussion of nuclear 'proliferation'/disarmament (London)
- Unclear at the outset that discussions would focus on Germany/too German orientated (Munich)
- No milk for the coffee (Munich)
- Too little time to design energy futures (Munich)
- Not enough information on findings of HONEST (Munich)

Several of these points are about practical issues (coffee, moving between rooms) that in a way are gratifying (if these were the worst things about the events, then the events must have been quite good!), but most, once more, refer to issues related to information and the context of its exchange – that is, concerning time limitations, lack of specificity, too much or too little information on a particular topic, disruptive individuals, and so on. Arguably, two main conclusions can be drawn from this list: the first is that the information translation perspective is an apt one to use for evaluating engagement, and the second is that participants generally had few complaints about the events in which they took part (which mirrors the previous generally positive evaluations).

With regards to how to improve the workshops, the suggestion made largely followed on from identified criticisms, and will not be discussed in any detail here. However, for reference, and to help inform the design and conduct of similar events in future, the suggestions were:

- Involve more stakeholders from large industries, as well as decision makers at a local, regional, national and international level (more diversity of participants) (Barcelona, Munich)
- More time e.g. over a second day (Barcelona, London, Munich)
- More/clearer information about aims at an earlier time (Barcelona, London)
- More information on profiles of attendees before the event, and information on their motivation to attend (Barcelona, London)
- Make more focused (Barcelona, London)
- Concentrate on history, not future (London)
- Language translation (from English) so more appropriate stakeholders can be involved (Munich)

- Include more countries (Munich)

Discussion

This brief report describes a small evaluation of the three stakeholder engagement events conducted in HONEST as part of WP6 (including the backcasting exercises of WP5). Because the evaluation has not been conducted by an independent third party, it has been deliberately restricted to participant views as collected through a questionnaire completed by approximately two-thirds of the participants from the three events – i.e. without third party commentary or analysis. Such an approach can, in itself, be problematic, as it relies upon the opinions of people who may not necessarily appreciate the background to an event or its limitations (such as temporal and financial). Furthermore, the reader needs to recognise that participants are not necessarily omniscient or fair in their assessments. People can be short-sighted, opinionated, distracted, ignorant, political, and even just unpleasant. Thus, to read too much into negative responses from one or two individuals (participants) would be inappropriate. However, when a number of participants come up with similar arguments, then it is as least worth considering what their issues are and what might be done about them! In the current case, however, there seems little to fear: the three different workshops were generally well received, seen as interesting opportunities to learn about the topic of nuclear energy and society - and to exchange views with stakeholders from different domains - in an open environment using a variety of interesting processes. Although a number of problems were noted, these did not seem to be major, and the organising team showed some learning throughout the event series, amending and improving the events from the first to the last – where they could! However, two significant issues will always bedevil events such as these: the first is simply that of *time*, as complex discussions invariably need, or could benefit from, much more time than busy and important stakeholders can conceivably give; and the second is the numbers and diversity of stakeholders attending, the recruitment of which is plagued by various practical difficulties – not least identifying relevant, well-resourced, diverse stakeholder who coincidentally can attend a particular event at a particular time. These issues, however, are not unique to HONEST and its interests, and play a role in limiting the efficacy of most, if not all, significant pieces of stakeholder engagement.

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Appendix 1: Evaluation Questionnaire

Dear Participant,
Thank you for having taken part in the workshop. We would now like to ask you a few questions about it as part of our evaluation of this project; we would be extremely grateful if you could complete this questionnaire. Please be assured that your responses will be treated anonymously. Although we ask for your name below, this is just so that we can make contact with you again for the evaluation (with your permission). Your name will not be cited in any evaluation report or associated with any comment you make here.
Thanks for your cooperation.

1. What is your name?

   ……

2. What is your affiliation?

   ……

3. Was it clear from the information you were sent prior to the event what the workshop was about?

   Yes ☐
   No ☐
   Unsure ☐

4. At the start of the workshop, were the aims clearly specified?

   Yes ☐
   No ☐
   Unsure ☐

5. Was it clear to you from the information you were sent prior to the event why YOU were invited?

   Yes ☐
   No ☐
   Unsure ☐

6. Was it made clear to you how the participants for this event were selected?
   Yes ☐
   No ☐

Unsure ☐

7. Do you think the audience was appropriate for this event?
   Yes ☐
   No ☐
   Unsure ☐

   If there were there any notable absentees, who were these?

   ……
   ……
   ……
   ……

8. During the event, did you have the opportunity to have your say?
I said all I wanted to say ☐
I said most of what I wanted to say ☐
I was only able to say a little of what I wanted to say ☐
I didn't get a chance to say anything ☐

9. Was there sufficient time to discuss all that needed to be discussed?
   Yes ☐
   No ☐
   Unsure ☐

10. Do you think there were any significant issues that were NOT discussed, but which should have been? What were these?

    ……
    ……
    ……
    ……

11. Were there any significant issues raised at the workshop that were not resolved? If so, what issues were these?

    ……
    ……
    ……
    ……

12. Did you learn much from the workshop?
    I learnt a lot of new things ☐
    I learnt a few new things ☐
    I'm not sure I learnt anything new ☐
    No, I did not learn anything new ☐

13. Did participation in this event change your views on the issues in any way?
    Yes, I changed my views considerably ☐
    Yes, I changed my views to some degree ☐
    I'm not sure whether I changed my views or not ☐
    No, I did not change my views in any way ☐

14. What information (from speakers, from written material, from other participants, etc.) did you think was particularly influential on your views?

    ……
    ……
    ……
    ……

15. Do you think the summing-up accurately reflected what was discussed at the workshop?

    Yes ☐
    No ☐
    Unsure ☐
    There was no summing up ☐

    If not, what do you think was missed or misconstrued?

    ……
    ……
    ……
    ……

16. Overall, do you think the workshop was well run?

    Yes ☐
    No ☐
    Unsure ☐
    If you said 'no', what was the main problem?

    ……
    ……

……
……
……
……

17. How satisfied were you with the event overall?
    - Very satisfied ☐
    - Fairly satisfied ☐
    - Neither satisfied nor dissatisfied ☐
    - Not very satisfied ☐
    - Not at all satisfied ☐
    - Unsure ☐

18. Do you expect any feedback from the event?
    - Yes ☐
    - No ☐
    - Unsure ☐

19. Did the event live up to your expectations?
    - Yes ☐
    - No ☐
    - Unsure ☐

    If not, why not?

……
……
……
……
……

20. Do you think this event will have any influence on relations between nuclear industry and society?
    - Yes ☐
    - No ☐
    - Unsure ☐

    Please explain your response.

……
……
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……
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21. Overall, what was the best thing about the workshop?

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22. Overall, what was the worst thing about the workshop?

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23. How do you think an event like this could be improved if something similar was run in the future?

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Once again, thank you for your time. Please hand your completed questionnaire to the event organizer when you leave.

END OF QUESTIONNAIRE